

AD-A174 346

HAZARDOUS WASTE MANAGEMENT: A DESCRIPTIVE STUDY(U) AIR
FORCE INST OF TECH WRIGHT-PATTERSON AFB OH SCHOOL OF
SYSTEMS AND LOGISTICS G M DREWETT SEP 86

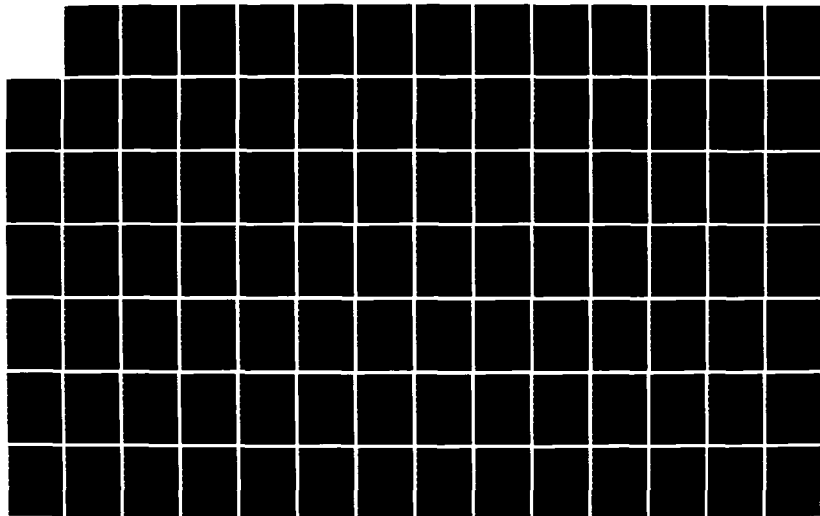
1/1

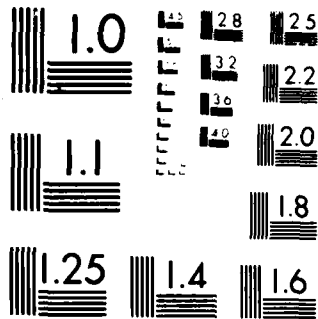
UNCLASSIFIED

AFIT/GEN/DEM/865-9

F/G 13/2

NL





MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS 1963-A

AD-A174 346



HAZARDOUS WASTE MANAGEMENT
A DESCRIPTIVE STUDY
THESIS

Mr. George M. Drewett

AFIT/GEM/DEM/86S-9

DISTRIBUTION STATEMENT A

Approved for public release
Distribution unlimited

DEPARTMENT OF THE AIR FORCE
AIR UNIVERSITY

AIR FORCE INSTITUTE OF TECHNOLOGY

Wright-Patterson Air Force Base, Ohio

DTIC
ELECTE
NOV 27 1986

B

86 11 25 247

DTIC FILE COPY

AFIT/GEM/DEM/86S-9

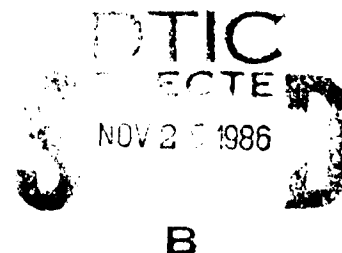
HAZARDOUS WASTE MANAGEMENT

A DESCRIPTIVE STUDY

THESIS

Mr. George M. Drewett

AFIT/GEM/DEM/86S-9



Approved for public release; distribution unlimited

The contents of this document are technically accurate, and no sensitive items, detrimental ideas, or deleterious information are contained therein. Furthermore, the views expressed in the document are those of the author(s) and do not necessarily reflect the views of the School of Systems and Logistics, the Air University, the United States Air Force, or the Department of Defense.



APPROVED	✓
NO	
DATE	
BY	
REMARKS	
A-1	

AFIT/GEM/DEM/86S-9

HAZARDOUS WASTE MANAGEMENT
A DESCRIPTIVE STUDY

THESIS

Presented to the Faculty of the School of Systems and Logistics
of the Air Force Institute of Technology

Air University

In Partial Fulfillment of the
Requirements for the Degree of
Master of Science in Engineering Management

George M. Drewett, B.S.E.

September 1986

Approved for public release; distribution unlimited

Preface

The purpose of this study was to provide decision-makers with a baseline profile of current Air Force hazardous waste management practices. Through the use of a twenty-six question survey, existing waste identification, storage, treatment, and disposal practices were identified.

Analysis of the survey results indicated three major problem areas in the Air Force's waste management program: 1) Inadequate manning, 2) Inadequate waste storage facilities, and 3) Lack of management support. Of these, the lack of management involvement in base hazardous waste management activities was the most surprising. Additional research into the reasons behind this lack of support appears warranted.

The preparation of this thesis would not have been possible without assistance from others. I wish to thank my advisor, Dr. Panos Kokoropoulos, for his patience and advice during this research effort. A special thanks to Dr. Fenno, my faculty advisor, your keen insight and good counsel were greatly appreciated.

To my wife Patti and daughters Katie and Kim, I thank you for your patience, understanding, and support during those many long nights when I was busily typing away.

George M. Drewett

Table of Contents

	Page
Preface . . . . .	.ii
List of Figures	v
List of Tables. . . . .	.vi
Abstract.	vii
I. Introduction.	1
General Issue.	1
Specific Research Problem.	3
Research Objectives.	3
General	3
Scope	3
Research Questions	4
II. Literature Review	5
Background	5
Resource Conservation and Recovery Act (RCRA).	9
Hazardous Waste Definition. . . . .	.10
Manifest Requirements . . . . .	.11
Generator and Transporter Standards . . . . .	.13
Treatment, Storage, and Disposal (TSD) Facility Requirements . . . . .	.13
Enforcement Provisions. . . . .	.14
State Operated Programs . . . . .	.15
Summary . . . . .	.15
Comprehensive Environmental Response, Compensation and Liability Act (CERCLA). . . . .	.16
Installation Restoration Program (IRP) . . . . .	.18
Phase I - Records Search. . . . .	.18
Phase II - Confirmation/Quantification. . . . .	.19
Phase III - Technical Base Development. . . . .	.19
Phase IV - Remedial Actions . . . . .	.19
Alternatives . . . . .	.20
Summary. . . . .	.22
III. Methodology . . . . .	.25
Overview . . . . .	.25
Selection of Population. . . . .	.25

	Page
Data Collection Plan . . . . .	.26
The Survey Questionnaire. . . . .	.26
Command EPC Minutes . . . . .	.27
Survey Implementation . . . . .	.28
Analysis Technique . . . . .	.28
Summary. . . . .	.29
IV. Findings and Analysis . . . . .	.30
Overview . . . . .	.30
Existing Waste Practices . . . . .	.30
Hazardous Waste Management Plan (HWMP). . . . .	.30
Waste Identification. . . . .	.32
Waste Storage Sites . . . . .	.35
Waste Disposal Practices. . . . .	.37
Waste Reduction Initiatives . . . . .	.38
EPC Support. . . . .	.39
Problem Areas. . . . .	.43
Notices of Violation (NOV's). . . . .	.43
Command Areas of Concern. . . . .	.48
Summary. . . . .	.49
V. Conclusion and Recommendations. . . . .	.50
Conclusions. . . . .	.50
Research Question One . . . . .	.50
Research Question Two . . . . .	.51
Research Question Three . . . . .	.52
Recommendations. . . . .	.53
Future Research. . . . .	.54
Appendix A: Survey Instrument. . . . .	.56
Appendix B: Survey Results . . . . .	.62
Appendix C: Pretest Survey Results . . . . .	.69
Appendix D: Command Identified Problem Areas . . . . .	.72
Appendix E: NOV Causes . . . . .	.75
Appendix F: Statistical Tests. . . . .	.78
Bibliography. . . . .	.80
Vita. . . . .	.83

List of Figures

Figure	Page
1. On-Site versus Off-Site Disposal.	8 .
2. Hazardous Waste Decision Tree . . . . .	.12
3. Hazardous Waste Treatment Hierarchy . . . . .	.23

List of Tables

Table	Page
I. Hazardous Waste Management Plan Profile. . . . .	.31
II. Hazardous Waste Management Program Responsibilities . . . . .	.32
III. Profile of AF Waste Identification Techniques. . .	.33
IV. Command Profile of Waste Identification Techniques. . . . .	.34
V. DRMO Waste Storage Profile . . . . .	.35
VI. Waste Storage Site Profile . . . . .	.37
VII. Profile of Waste Reduction Initiatives . . . . .	.38
VIII. Comparison of Mean HWMP and EPC Support Ratings. .	.41
IX. Command Profile of HWMP and EPC Support Ratings. .	.42
X. AF Notices of Violation (NOV's). . . . .	.43
XI. Comparison of HWMP and EPC Support Ratings for Installations with/without Dedicated HWMP Staff. .	.45
XII. HWMP vs EPC Support Rating Statistical Parameters . . . . .	.46

Abstract

The increased emphasis and enforcement of the RCRA regulations by the US EPA has prompted AF managers to reevaluate base hazardous waste management activities. This research effort provides management with a profile of the current state of affairs of waste management within the Air Force community. This profile provides the necessary baseline data for managers to develop and support future hazardous waste management initiatives.

A census of all CONUS base environmental Coordinators was used to identify existing base hazardous waste management practices. The data obtained in this research effort identified three major problem areas: 1) Inadequate environmental manning, 2) Inadequate waste storage facilities, and the 3) Lack of EPC involvement in the base's hazardous waste management program.

Additional research into the underlying reasons for this lack of EPC support is recommended.

HAZARDOUS WASTE MANAGEMENT
A DESCRIPTIVE STUDY

I. Introduction

General Issue

The passage of the Resource Conservation and Recovery Act (RCRA) of 1976 was an attempt by Congress to quickly respond to the mounting public concern stemming from the improper handling and disposal of hazardous waste products in the United States (20:19). Prior to the RCRA regulations, industries, municipalities, and government agencies alike were essentially unregulated and typically disposed of their waste products in landfills, open pits, ponds and/or lagoons (5:107-109; 15:230). Studies conducted by the United States Environmental Protection Agency (EPA) in the late 1970's, indicated that less than ten percent of the hazardous wastes generated in this country were being disposed of in an environmentally safe manner (2:20; 13:755; 14:51; 25:30).

Tasked with developing a national "cradle to grave" hazardous waste management system by Congress, the EPA began formulating rules and regulations pursuant to the RCRA statute in late 1976. EPA's objective was to create a comprehensive tracking and record keeping system for the generation, transportation, storage, and disposal of hazardous wastes (20:19). The initial phase of these rules became effective on the nineteenth of November 1980, two

years after the Love Canal disaster (17:66). These initial rules were updated in January of 1981 to include minimum standards for sites being used to store, treat, and dispose of hazardous waste. The EPA again in November of 1984 amended the original RCRA regulations. These amendments essentially banned the disposal of many of the most dangerous hazardous wastes in landfills, and extended the RCRA provisions to anyone producing more than 220 pounds (100 Kg) of wastes per month (3:60). Unfortunately, the RCRA regulations do not govern the estimated 20,000 to 50,000 existing hazardous waste dumps, many of which are now abandoned and/or leaking (1:1; 2:20; 3:60; 24:286A). Recognizing this shortcoming, the EPA promulgated the Comprehensive Environmental Response Compensation and Liability Act (CERCLA) of 1980, commonly referred to as the "Superfund" bill, to identify and clean up past hazardous waste disposal sites (1:1-2; 3:60-61; 11:443). Whereas the focus of RCRA is on controlling and managing new hazardous waste, CERCLA is concerned with the location and decontamination of past uncontrolled hazardous waste sites (11:443; 18:441).

The increased emphasis on compliance with the RCRA regulations and the potential for adverse publicity and lawsuits stemming from past improper waste disposal activities, has significantly increased the responsibilities of base level personnel associated with hazardous waste management actions. Since the military generates over

530,000 tons of hazardous waste each year, it is imperative that these products be properly managed to minimize DoD liabilities (30). HQ USAF/LEEV wishes to determine the current status of the Air Force's hazardous waste management program.

Specific Research Problem

Managers at the headquarters level have insufficient information to evaluate the adequacy of the current Air Force hazardous waste management program. Although this program has been in existence for over five years, no baseline data exists which could be used to determine how effectively base level programs are functioning. This research effort provides management with a baseline profile of the current state of affairs of waste management within the Air Force community. The profile provides managers with the necessary baseline data required to support and develop future Air Force hazardous waste management initiatives.

Research Objectives

General. The main thrust of this research effort was to obtain baseline data on current Air Force hazardous waste management practices, and to identify major problem areas facing base level Environmental personnel.

Scope. A descriptive study limited to CONUS Air Force installations was used to identify current hazardous waste management practices. The study consisted of a twenty-six question survey administered to installation Environmental

Coordinators (EC), and a review of command Environmental Protection Committee minutes for the period of 31May85 through 31May86. Minutes from the following headquarters were reviewed under this research effort; AFLC, AFSC, MAC, SAC, and IAC.

Although the data collected in this research effort include input from only major Air Force installations, the results generally apply to all Air Force sites and should be representative of typical practices seen at other Department of Defense installations. Since this research effort is descriptive and exploratory in nature, no attempt was made to explain or resolve problems identified, instead this report only lists existing site conditions.

Research Questions

The following questions were used to obtain the real world snapshot picture of hazardous waste management practices currently being employed at Air Force bases.

1. What are the existing hazardous waste management practices at AF installations?
2. What role does the Environmental Protection Committee (EPC) play in supporting the base's waste program?
3. What are the major problem areas currently facing Air Force Environmental personnel?

The survey portion of this study was used to answer the first two questions, while the command EPC minutes were used to answer the last.

II. Literature Review

Background

The affluence and rapid growth experienced in the United States during the 1960's and 70's resulted in a huge increase in the amount of waste generated and which required disposal. In 1974 the EPA estimated that the United States generated approximately 500 million metric tons of waste, of which 30-40 million tons were considered hazardous (6:3; 15:230). Prior to the enactment of the Resource Conservation and Recovery Act (RCRA) in 1976, these wastes were typically disposed of at unregulated and essentially uncontrolled disposal sites (5:107; 15:230). Although individual hazardous waste sites did vary considerably in size and characteristics, the most common methods used during this period were landfills, surface impoundments, evaporation lagoons, and waste piles (1:4; 13:755; 39:215). Among fifty-three of the largest chemical companies, landfilling was the preferred method of disposal (14:50-51).

The "Love Canal" and "Valley of the Drums" incidents of the late 1970's first alerted the general public to the real dangers associated with the improper handling of hazardous wastes (13:756; 17:66). Prior to these disasters the prevailing public attitude was one of "out of sight, out of mind." To protect human health and the environment from further deterioration, Congress enacted the Resource

Conservation and Recovery Act (RCRA) in October of 1976 and tasked the Environmental Protection Agency (EPA) with the development of a national hazardous waste management system (19).

The initial phase of the EPA's "cradle to grave" approach to hazardous waste management became law on the nineteenth of November 1980 and included in excess of 6,000 pages of text (7:777; 34:359). Unlike previous environmental laws which focused only on effluent discharge levels, the RCRA rules attempted to regulate the total hazardous waste process, from waste generation through ultimate disposal. This was to be accomplished through the use of a comprehensive tracking and record keeping system and the implementation of minimum acceptable standards for all generators, transporters, and treatment, storage and disposal (TSD) facilities involved with hazardous wastes (6:3; 20:19). In 1981, one year after the initial RCRA rules became law, the EPA reported that there were approximately 14,000 hazardous waste generators in this country (1:1). Subsequent reports conducted by the National Academy of Sciences and the Office of Technology Assessment indicate that the country generated between 260 and 320 million metric tons of hazardous waste in 1981, and that as much as eighty percent of these products were being disposed of in or on the land (3:60; 22:281A; 27:313). The passage of the RCRA regulations represented a major step forward in this country's battle against hazardous waste pollution. The regulations were not however a panacea.

and several significant shortcomings soon became apparent;

1. The RCRA provisions did not regulate past waste disposal sites.

2. The RCRA provisions resulted in a large increase in the quantities of wastes classified as hazardous.

3. The EPA was not adequately staffed nor its personnel trained to effectively manage and enforce the RCRA program (36:83).

4. An acute shortage of environmentally suitable waste disposal facilities existed (13:758).

Congress resolved the first of these problems by enacting the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) in 1980. Commonly referred to as the "Superfund Bill", CERCLA gave the EPA broad authority to identify and clean up old waste disposal sites (11:443). Unlike RCRA, the CERCLA regulations do not contain a "grandfather clause" provision, and responsible parties (generators, disposers, and/or owners) remain liable for their wastes forever (5:115). Although the EPA has attempted to remedy the remaining RCRA shortcomings, they remain essentially unresolved.

Like the civilian sector, the Department of Defense (DoD) generates large quantities of hazardous wastes each year (30). These wastes typically result from industrial operations such as; painting, degreasing, aircraft repair, and fuel storage and supply. Typical AF wastes include the

following; acids, heavy metals, caustic solvents, paint strippers and thinners, and waste pesticides (4:31).

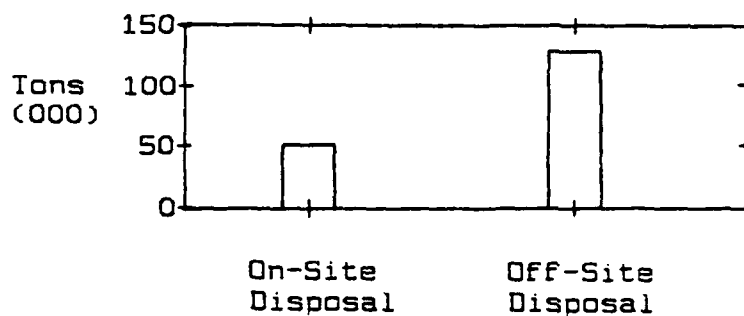


Figure 1. On-Site versus Off-Site Disposal (4:36)

Typically DoD installations dispose of the majority of their waste products off-site via contract. Figure 1 depicts graphically the amount of wastes disposed of on-site and off-site for 300 DoD installations in 1981.

Increased public concern stemming from the "Love Canal, Times Beach, and Hooker Chemical Company" incidents has resulted in a renewed effort by the EPA to identify and prosecute RCRA and CERCLA violations (32; 33). The EPA apparently has Presidential support on these issues as evidenced by its 1986 budget which calls for a twenty percent increase for enforcement and \$1 billion dollars for hazardous waste related activities (12). Since DoD no longer enjoys sovereign immunity, it is imperative that its installations effectively manage the hazardous wastes they generate. Failure to do so, could result in adverse publicity and/or

finances against the Department of Defense.

The remainder of this chapter will focus on identifying the major provisions of the key environmental statutes and their possible impact on Air Force hazardous waste management programs.

Resource Conservation and Recovery Act (RCRA)

The Resource Conservation and Recovery Act (RCRA) of 1976 requires that anyone storing, transporting, treating, or disposing of hazardous waste products must obtain a permit from the Environmental Protection Agency (EPA) prior to commencing operations (3:60). Although the RCRA rules regulate hazardous wastes from generation through disposal, the emphasis of the statute is one of conservation rather than disposal (18:441). The RCRA regulations can be divided into six major sections or divisions (15:231-232; 35:20,24);

1. Hazardous waste definition.
2. Manifest requirements (tracking system).
3. Standards for hazardous waste generators and transporters.
4. Standards and permit requirements for treatment, storage, and disposal (TSD) facilities.
5. Enforcement procedures.
6. State operated hazardous waste management programs.

Since these regulations apply equally to all federal agencies and instrumentalities (10:28), a closer look at each key

section and its potential impact on Air Force installations follows.

Hazardous Waste Definition. A hazardous waste is defined by the EPA to be;

any liquid, sludge, solid or gaseous material or combination thereof which, due to its quantity, concentration, or individual characteristics may, when not properly controlled, introduce or pose a potential hazard to an individual's health or his environment (23:15).

A waste product is classified as "hazardous" under RCRA if any one of three conditions is met;

1. The waste is listed as hazardous in 40CFR261.
2. The waste is a byproduct from a process listed in 40CFR261.
3. The waste exhibits ignitability, reactivity, corrosivity, or toxicity characteristics as outlined in 40CFR261.

The RCRA regulations clearly state that it is the responsibility of the generator of a waste product to determine if it is hazardous or not. This determination can be accomplished either by actual sampling and analysis or by local process knowledge. Regardless of which method the generator chooses, adequate documentation must be available for EPA inspection and verification. Essentially all solvents, fuels, oils and paints used at Air Force installations could be classified as hazardous wastes under this definition. It is therefore imperative that any Air

Force personnel using these types of materials be aware of their potential hazards and effectively manage (store, collect, or recycle) any wastes they might generate. A significant problem being experienced at many AF sites is the inability to effectively segregate and classify wastes. The problem is often complicated by the total absence of analytical capabilities at the base level. Lack of information leads to inaccurate or "worst case" classification of Air Force waste streams, resulting in higher disposal costs, notices of violation and other non-compliance situations (30). Figure 2 illustrates an "ideal" decision tree for hazardous waste determination. Unfortunately, few if any Air Force installations use one standard methodology for classifying wastes as hazardous.

Manifest Requirements. All generators of hazardous wastes are required to ensure that their wastes are transported, treated, and disposed of by licensed haulers and permitted disposal facilities. The law clearly holds the generator responsible for the hazardous waste until it is certified as destroyed by the disposal facility. However, in many cases the generator's responsibility does not end with the wastes destruction. The city of New York recently indicted fourteen hazardous waste generators with the charge that they knew or should have known that their wastes were being disposed of improperly (5:115). Since the majority of Air Force installations contract out the transportation and

Protocol For Determination of Hazardous
Waste Generation

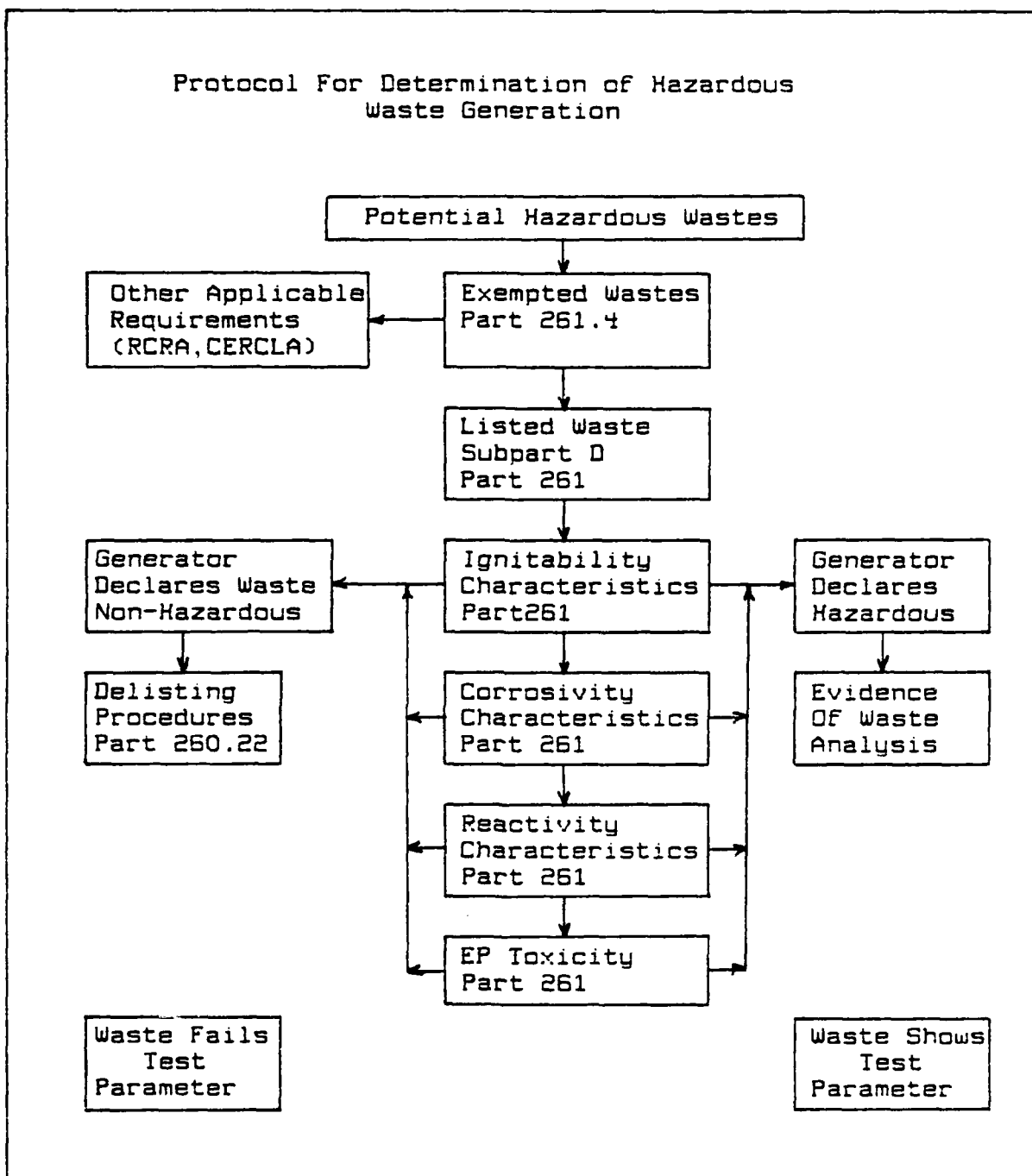


Figure 2. Hazardous Waste Decision Tree (23:16)

disposal of their waste, increased attention to strict contract compliance is paramount if potential base liabilities are to be minimized.

Generator and Transporter Standards. Hazardous waste generators are required under the RCRA regulations to identify, store, manifest, and inspect all on-site or off-site ISDF's. Records of these activities along with employee training records and contingency plans must be maintained for a three-year period. Hazardous waste transporters are required to obtain a RCRA permit to haul waste products and are not allowed to accept any waste not properly labelled and manifested. All shipments must then be transported directly to the prescribed disposal facility. Air Force personnel responsible for hazardous wastes need to establish and maintain the required identification, inspection, and contingency plans for all base hazardous wastes/shipments.

Treatment, Storage, and Disposal (TSD) Facility Requirements. This section of the regulations outlines the minimum acceptable standards for the safe storage, treatment, and disposal of hazardous wastes. Air Force installations typically become involved only with the storage portion of this section. If hazardous wastes are stored on-site in excess of ninety days, the wastes must be stored at locations which meet or exceed the guidelines provided in this section. These minimum standards include requirements such as;

1. Storage areas must be protected from the weather.
2. Storage area floors must be impermeable.
3. Storage areas must be diked to contain 150 percent of waste capacity.
4. Storage areas must be alarmed and secure.

This list is not intended to be exhaustive, it does however illustrate the degree of protection and control the EPA is seeking for hazardous waste storage facilities. Typically, Air Force bases cannot meet these storage requirements and should therefore establish procedures to ensure the removal of waste products prior to the ninety day time limit. Efforts are now underway by the Defense Logistics Agency (DLA) to upgrade their existing storage yards to meet the RCRA specifications. Nationwide however, there still exists an acute shortage of environmentally sound hazardous waste facilities (13:758).

Enforcement Provisions. Enforcement of the RCRA regulations can include any or all of the following (31; 34:357; 35:28):

1. \$25,000/day/incident fine.
2. One year imprisonment.
3. Civil lawsuits.
4. Criminal lawsuits.

These actions are directed at the installation commander who is personally responsible for compliance. Even with these stiff penalties "midnight dumping" of hazardous wastes continues to be a major problem area (26:31).

State Operated Programs. This section of the regulations contains the necessary guidelines for states wishing to administer their own hazardous waste management program. Those Air Force installations located in states with an EPA approved Hazardous Waste Management Program must comply first with the state's and then the federal EPA's requirements.

Summary. The Resource Conservation and Recovery Act of 1976 represents a major step forward by this country to eliminate or at least minimize the potential for future hazardous waste pollution sites. The 1984 amendments to RCRA echo this ideal. These amendments extended the coverage of RCRA to include any individual generating in excess of 220 pounds (100Kg) of hazardous waste per month, outlawed the disposal of many wastes in landfills, and established an underground storage tank program (3:60; 9; 10). Unfortunately the success of the RCRA regulations centers on the ability of matching the number of disposal facilities with the wastes being generated by this country (13:804). At this time however, this is sadly not the case and generators are struggling to get their wastes destroyed.

Comprehensive Environmental Response, Compensation and Liability Act (CERCLA)

A growing concern over groundwater contamination and the discovery of an ever increasing number of improperly operated or abandoned hazardous waste disposal sites, has resulted in a renewed emphasis on the safe handling and disposal of hazardous wastes (16:330A). Although the Resource Conservation and Recovery Act of 1976 regulates the storage, transport, and disposal of most new wastes (after 1980), the rules are silent concerning the estimated 33,000 to 50,000 old waste dumps scattered across this country (2:20; 3:60; 24:286A). To remedy this obvious shortcoming Congress passed the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) in 1980.

Better known as the "Superfund bill", CERCLA gives the EPA broad authority to identify and clean up hazardous waste pollution sites (1:1-2; 3:60-61). Under this act any generator, transporter or disposal agent who contributed wastes to an identified pollution site is liable for some or all of the associated clean up costs for that site. Since the CERCLA regulations have no grandfather clause, customers and owners of waste disposal sites are effectively liable for their waste products forever (11). This enormous potential liability now faces many U.S. firms, even though many may have complied with all the regulations in effect at the time of disposal (3:60). This liability is indeed significant as few clean up operations at old waste disposal sites are

inexpensive. The Office of Technology Assessment (OTA) estimates that over \$100 billion dollars is required to clean up pollution sites known today (5:118). Other experts estimate that as much as \$680 billion dollars will be needed to meet this country's clean up problems through the 1980's (24:289A; 40:39).

While the focus of the CERCLA regulations is to identify and clean up past disposal sites (11:443), an OTA study of ongoing Superfund clean up projects indicates that most of the CERCLA wastes being recovered are merely being redrummed and shipped to alternate landfill locations (5:118; 29:46). This finding is extremely distressing in light of the fact that many experts believe that landfills can never be made safe and that land disposal will always pose a considerable threat to public health (2:24; 28:22). Although alternative disposal methods are fifty to one hundred percent more expensive than land disposal today, the costs associated with cleaning up newly created pollution sites years from now could run from ten to one hundred times this current additional outlay (22:282A). The intent of the Comprehensive Environmental Response, Compensation and Liability Act is quite clear, to identify and where necessary clean up past waste disposal sites. Unfortunately the methods currently being used to achieve this end do not appear to be effective nor environmentally sound.

Installation Restoration Program (IRP)

In 1984 the military generated approximately 530,000 metric tons of hazardous wastes (30). The vast majority of these wastes originated from industrial operations such as metal finishing, degreasing, painting and stripping, aircraft repair/maintenance, and fuel storage and supply (4:31). Since the Comprehensive Environmental Response, Compensation and Liability Act of 1980 mandates federal agencies to administer their own remedial action programs, including funding, the Department of Defense established the Installation Restoration Program (IRP) as the vehicle for identifying and remediating DoD uncontrolled waste disposal sites (1:2; 4:33; 11:443). The objectives of the DoD Installation Restoration Program are twofold;

to (1) identify and evaluate suspected problems associated with past hazardous material disposal sites located on DoD installations and (2) control contamination from these sites (1:6).

The IRP process within the DoD utilizes a four phase systematic approach for determining the location and severity of Air Force waste disposal sites.

Phase I - Records Search. Efforts performed during this initial phase center on identifying through oral and written information, past waste disposal practices used at the suspected site. Based on this information individual sites are ranked using the Air Force's Hazard Assessment Rating Methodology (HARM). Any site receiving a sufficiently high

HARM rating is considered for future Phase II or Phase IV activities. Those sites which receive low HARM scores are considered to represent no apparent hazard and receive no further actions. A detailed description and analysis of the Air Force's HARM program can be found in Mr. Myron Anderson's Thesis entitled "Validation of Air Force Hazard Assessment Rating Methodology" (1).

Phase II - Confirmation/Quantification. The objectives of the second phase of the IRP process are to confirm the presence of contamination, to determine the extent of contamination, and to decide on the appropriate remedial actions. Once contamination has been confirmed, either remediation or research and development occur.

Phase III - Technical Base Development. IRP's third phase involves the research and development necessary for the implementation of new treatment technologies. A recent example of this type of effort occurred at Wurtsmith AFB Michigan where a full scale countercurrent air stripping tower was designed, installed and tested (37). Data obtained from this unit verified the feasibility of air stripping for the removal of volatile organic chemicals (VOC's) from groundwater.

Phase IV - Remedial Actions. Remedial actions at a contamination site may include any or all of the following activities;

1. Contaminant removal.

2. Contaminant treatment.
3. Contaminant monitoring.
4. No action.

The remedial action implemented under Phase IV depends on the extent, type, and hazard associated with the contamination site.

The majority of Air Force installations have completed the first phase of the DoD Installation Restoration Program. Preliminary estimates indicate that approximately \$5 billion to \$10 billion dollars will be required to clean up some 473 military sites across the country (5:118). The Air Force alone is expected to expend in excess of \$1 billion dollars through 1991 (1:3).

Alternatives

Even though many experts believe that landfills can never be made totally safe, and the mood within the Congress has shifted away from land disposal of hazardous wastes, eighty to ninety percent of the hazardous wastes generated in this country continue to be dumped into waste landfills (2:24; 21:21-22; 28:23). Unlike the United States, most European countries have almost entirely phased out the use of landfills as an acceptable method for hazardous waste treatment (22:284A; 28:22). Instead, hazardous waste products are detoxified and then thermally destroyed in high temperature incinerators (28:23).

Although landfilling continues to be the cheapest method

of disposal in this country (2:24), several alternative techniques to land disposal are available (5:118);

1. Waste Recycling.
2. Waste Transformation.
3. Thermal Treatment.
4. Chemical Treatment.
5. Biological Treatment.

Of these, thermal destruction systems or incinerators provide the most complete means of disposal (22:283A; 27:312).

Unfortunately these alternatives are typically more expensive than is land disposal and industry has no incentive to use them (2:24). The EPA estimates that the United States will need approximately eighty-three land based and thirty-three ocean going incinerators by 1990 to adequately treat our nations hazardous wastes (5:122). Since there are currently only four land based and one ocean going incinerators approved by the EPA (5:122), it is readily apparent that this country may soon be unable to effectively and safely dispose of the hazardous wastes it generates.

The National Academy of Sciences (NAS) recommends that hazardous wastes be treated by one or more of the following three general methods (22:282A);

1. Elimination, reduction or reuse of the waste.
2. Conversion of the hazardous waste.
3. Perpetual storage of the hazardous waste.

Of these, NAS considers the first to be the most economical and effective method for managing hazardous wastes (4:37; 5:109; 22:282A). Figure 3 depicts the NAS's recommended waste treatment hierarchy. Although we have the technology to effectively treat our hazardous wastes, we lack the sustained political will necessary to implement these recommendations (28:27).

Summary

Although the EPA has implemented a solid cornerstone for the safe handling of hazardous waste products with the RCRA and CERCLA regulations, significant hurdles still remain. The most pressing of these problems appear to be; an insufficient number of suitable waste treatment/disposal facilities, an overdependence on land disposal techniques, and a general distrust of the EPA by the public at large. If progress is to be made in resolving these issues, the government, the environmental community, and the business community alike, must all work together in a cooperative and objective forum (36:83).

The hazardous waste problems facing the military are very similar to those found in the civilian sector. Typically Air Force installations do not have the technical expertise, money, nor dedicated manpower necessary to effectively manage their hazardous wastes (30; 38:12). A

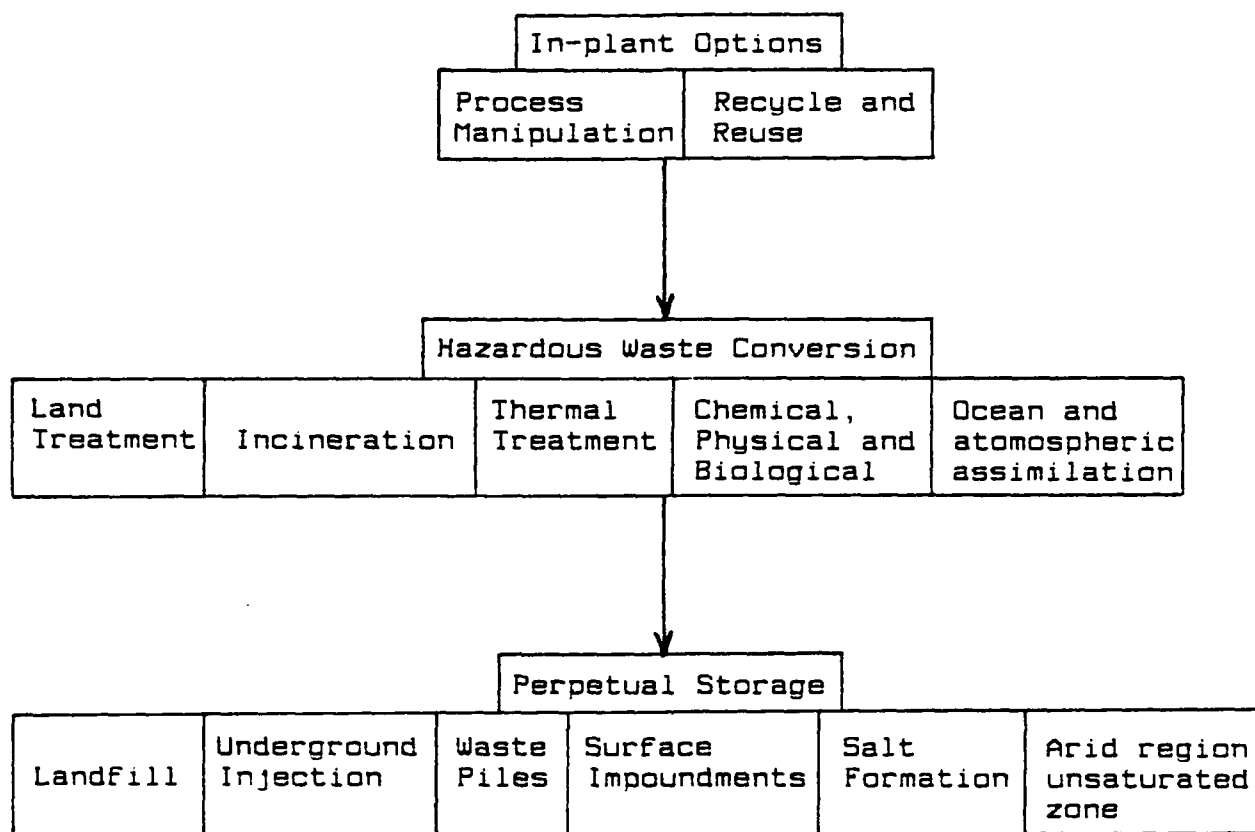


Figure 3. Hazardous Waste Treatment Hierarchy (22:283A)

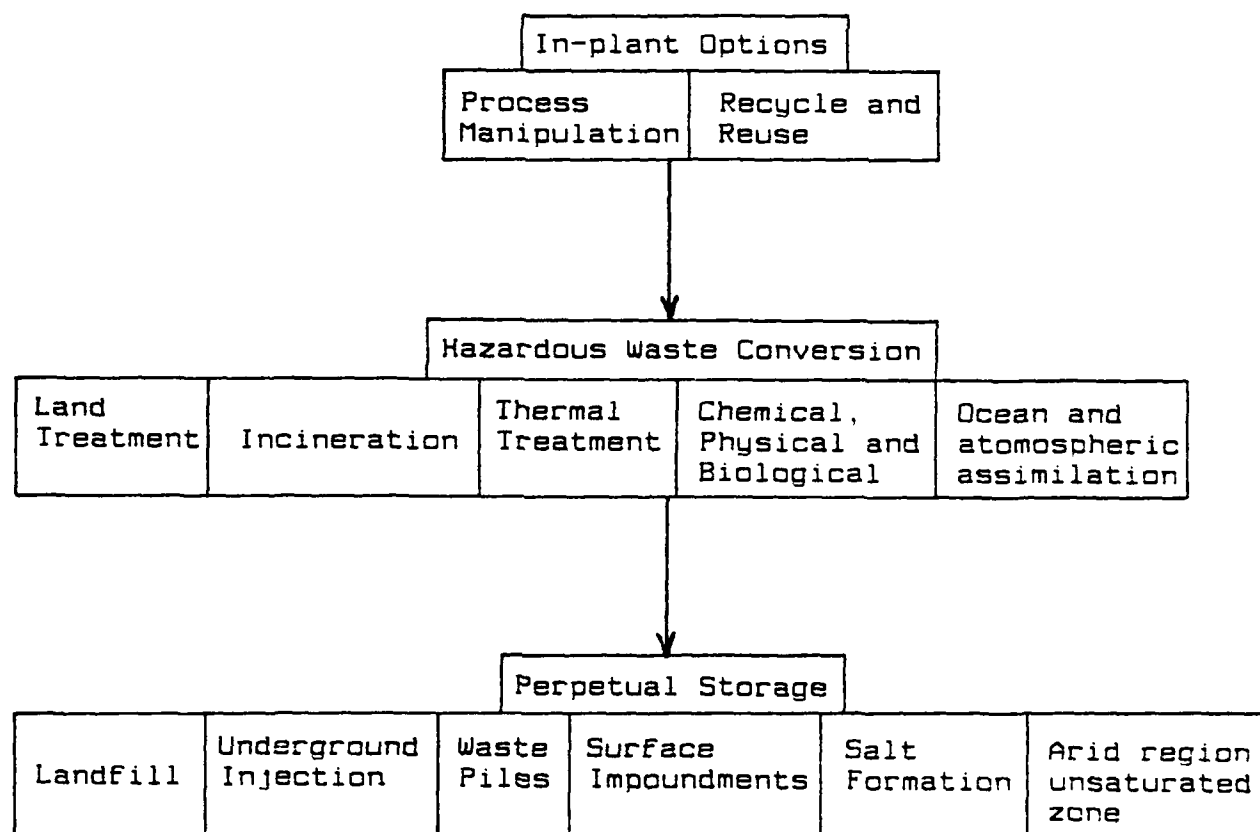


Figure 3. Hazardous Waste Treatment Hierarchy (22:283A)

recent Inspector General (IG) survey of seventy-two military facilities concluded that;

(1) Programs to minimize hazardous materials and hazardous wastes are fragmented and ineffective. (2) Training and education of hazardous material handlers, supervisors and commanders is inadequate where it does exist (30).

It is apparent that to remedy these types of issues the military needs to better educate its personnel on the importance of safe and effective hazardous waste management practices.

III. Methodology

Overview

This chapter describes the procedures used to accomplish the research objective and to answer the investigative questions presented in Chapter I. The chapter also describes the population from which the data were collected, the method of data collection, and the procedures used to analyze the data.

Selection of Population

The population of interest was identified as all GS-11/12 civilians and O-1/2 officers assigned as base Environmental Coordinators. As the focal point for local waste management activities, these individuals are uniquely knowledgeable about current waste identification, storage, treatment, and disposal practices. A computer listing of all CONUS Air Force bases was obtained from the ATLAS Variable Inquiry System. Due to the small size of the population, data collection from one hundred percent of the base Environmental Coordinators was attempted.

Additional support data were also obtained through the review of Command Environmental Protection Committee (EPC) minutes for the period of 31May85 to 31May86. These minutes were used to identify and verify existing hazardous waste management problem areas. Copies of the EPC minutes from the

following major commands were reviewed during this research effort;

1. Air Force Logistics Command (AFLC).
2. Air Force Systems Command (AFSC).
3. Military Airlift Command (MAC).
4. Strategic Air Command (SAC).
5. Tactical Air Command (TAC).

By analyzing both the subjective data (survey results), and the objective data (EPC minutes), a complete picture of the Air Force's hazardous waste management program was determined.

Data Collection Plan

The Survey Questionnaire. Based on the size and nationwide distribution of the population, and the type of data desired (i.e. an AF profile), the logical choice for the data collection system was the survey instrument or questionnaire. A twenty-six question survey was developed to identify both descriptive data and personal opinions concerning the Air Force's Hazardous Waste Management Program (HWMP). A sample copy of the survey instrument along with a listing of individual response are included as Appendices A and B to this report.

The survey questionnaire was broken down into five major sections;

1. General Information.
2. Hazardous Waste Management Plan Development.
3. Environmental Protection Committee Support.
4. Existing Hazardous Waste Practices.
5. Problem Areas.

Care was taken to ensure that the survey questions were clear, concise and easy to answer. While some questions requested "yes" or "no" answers, most questions required responses that could be categorized into one of the five major sections listed above.

To test the validity of the questionnaire, it was administered to a test group of students attending the School of Civil Engineering's Hazardous Waste Management course, MGT 521. Survey results from the pretest are included as Appendix C.

Command EPC Minutes. The command Environmental Protection Committee minutes were used to both identify and verify significant problem areas within the Air Force's hazardous waste management community. It was anticipated that this data would indicate classes of problem areas which were command specific and/or Air Force wide. A listing of the problem areas identified from the command EPC minutes is included as Appendix D. Those problem areas identified by base Environmental Coordinators in response to survey question number twenty-six are listed in Appendix E.

Survey Implementation. The survey instrument was approved by OCPO and HQ Air Force Manpower and Personnel Center (HQ AFMPC/DPMYOS) by letter on 16 June 86. Distribution of the survey questionnaires to all eighty base Environmental Coordinators by office address was completed by 23 Jun 86.

A high response rate was anticipated based on the applicability of the research subject to base environmental personnel. A total of eighty surveys were distributed, of which seventy-four were completed and returned. This represents a response rate of over ninety-two percent.

Analysis Technique

To meet the research objectives of this report, a frequency analysis approach was used. Survey and literature review results were categorized, and relative frequencies of occurrence identified. Basic percentages and histograms were then used to illustrate Air Force wide or command unique "trends" and/or problem areas. From the trends, a profile of base level hazardous waste management practices was determined.

Although descriptive in nature, this study provides many useful insights into the strong and weak points of waste management practices within the Air Force. The trends and the problems areas identified provide decision-makers, at the headquarters level, the necessary baseline data to evaluate future hazardous waste initiatives and expenditures. Even

though this study only addressed Air Force practices, the trends and problem areas highlighted should be applicable to other DoD organizations (Army, Navy, etc.).

Summary

The profile developed under this research effort does indeed provide a cross sectional view of current Air Force hazardous waste management practices. This is evidenced by the inclusion of data from each of the following major commands; AIC, AFSC, AFLC, MAC, SAC, and IAC.

IV. Findings and Analysis

Overview

This chapter presents a description of the data collected pursuant to the methodologies outlined in Chapter III and answers research questions one, two, and three. The data are divided into three major sections: 1) Existing Waste Practices, 2) EPC Support, and 3) Problem Areas. Each section is concluded with an analysis of the relevant findings.

Existing Waste Practices

To describe existing hazardous waste management practices, data dealing with the identification, storage, treatment, and/or disposal of hazardous wastes were extracted from responses to the survey questionnaire. This information was then used to analyze the following key waste management activities;

1. Management Plans.
2. Waste Identification Practices.
3. Storage Site Conditions.
4. Waste Disposal Practices.
5. Waste Reduction Initiatives.

Hazardous Waste Management Plan (HWMP). The hazardous waste management plan is the single administrative document which describes the what, where, how and why of hazardous

waste management activities at the base level. The plan outlines the types, quantities, and location of all hazardous materials used or generated at the installation, and identifies potential high risk spill locales. Recommended remedial materials (sorbent booms, sandbags, etc.) and response alternatives are also included in the plan.

TABLE I

Hazardous Waste Management Plan Profile

Command	# of Responses	Written Plan	EPC Approved
AFLC	6	6	1
AFSC	7	7	7
MAC	11	11	11
SAC	23	20	18
TAC	15	14	13
ATC	10	9	9
Other	2	1	1

The data clearly indicate that the vast majority of Air Force installations (68 out of 74) have established formal written procedures for the management of their hazardous wastes. The data also show that over eighty-eight percent of these plans have been approved by the base Environmental Protection Committee (EPC). Since most hazardous waste problems are seldom simple, group involvement and interaction are

essential if timely and acceptable solutions are to be implemented. Although the data presented in Table I appear to indicate a group approach to hazardous waste management, they do not tell the whole story.

TABLE II

Hazardous Waste Management Program Responsibilities

Responsible Agent	HWMP Author	HWMP Maintenance
Environmental Coordinator	58	62
EPC Subcommittee	3	4
Special Task Group	2	1
Contractor	5	2
Other	4	4

Over eighty percent of the survey respondents indicated that the base Environmental Coordinator was solely responsible for the writing, implementation, enforcement, and updating of their Hazardous Waste Management Plan (HWMP). This seems to indicate that even though base EPC's are approving local waste management plans, they are not actively involved in the management of base level hazardous waste activities.

Waste Identification. The RCRA regulations require all generators to determine which of their waste products are hazardous. This determination can be accomplished either through routine chemical analysis or by local process stream

knowledge. Regardless of which method is employed, the generator assumes full responsibility for the accuracy of the waste analysis.

TABLE III

Profile of AF Waste Identification Techniques

Method	Frequency
Generator/User Input	51 of 72
Labels & Warnings	45 of 72
Chemical Analysis	42 of 72
Material Safety Data Sheets	40 of 72
Bioenvironmental Engineer Input	38 of 72
Environmental Coordinator Input	37 of 72

Table III lists the six most frequently identified methods for waste determination on AF installations. The data strongly suggest that no single waste identification methodology is currently being used by AF personnel. This finding is extremely disconcerting as only routine chemical analysis can provide the required accuracy and quantification necessary to ensure RCRA compliance. Forty-nine out of seventy-two respondents indicated they were using three or more methods to identify hazardous wastes, while fewer than twenty-five percent (15 out of 72) were using only one method. The implication associated with this finding is

TABLE IV

Command Profile of Waste Identification Techniques

Command	One Method	Two Methods	Three or more Methods
AFLC	1	2	3
AFSC	1	1	5
MAC	4	0	7
SAC	5	5	13
IAC	0	0	13
ATC	3	0	7
Other	1	0	1

that no standard procedure currently exists within the AF community on how to identify hazardous wastes. Faced with this dilemma, base environmental personnel are apparently using whatever information is most readily available to classify their waste streams. Since the composition of most AF waste streams varies considerably from day to day, or base to base, it is highly unlikely that the present system is either effective or accurate. Unfortunately, not knowing does not relieve the generator (base) of its responsibility under the RCRA or CERCLA regulations. Increased emphasis on accurate waste identification through chemical analysis is imperative.

Waste Storage Sites. The RCRA regulations established minimum acceptable standards for the storage of hazardous wastes. On AF installations, hazardous wastes are typically stored at either waste accumulation points or in waste storage facilities. The major difference between the two being the duration of waste storage. Any hazardous waste which is stored in excess of ninety days must be housed in an EPA approved waste storage facility. If the length of

TABLE U

DRMO Waste Storage Profile

Command	Number of Responses	Serviced by DRMO	DRMO Accepts & Stores Wastes
AFLC	6	6	5
AFSC	7	5	3
MAC	11	11	4
SAC	22	22	16
IAC	13	13	10
ATC	10	9	5
Other	2	2	1

storage is less than ninety days, less stringent requirements apply. Within the DoD, the responsibility for long term storage of hazardous wastes rests with the Defense Reutilization and Marketing Office (DRMO). Although DRMO's are tasked with the storage of hazardous wastes, not all

bases are serviced by a DRMO. The data portrayed in Table U indicate that the vast majority of CONUS AF installations are serviced by a DRMO facility. A major problem facing many DRMO's is the inadequacy of their existing hazardous waste storage facilities. Even though efforts are underway through the Military Construction Program (MCP) to remedy this situation, many AF installations do not have access to an acceptable storage facility and wastes must be stored at marginal or substandard locations. Although DRMO's service approximately ninety-five percent of the bases surveyed, only sixty-four percent were accepting and storing base hazardous wastes. The major reason why DRMO's were not accepting or storing hazardous wastes was the lack of an adequate hazardous waste storage facility. Military Airlift Command (MAC) and Air Training Command (ATC) bases appear to be hardest hit by this problem as only nine out of twenty DRMO's were accepting and storing hazardous wastes.

Only nineteen out of seventy-two AF storage/accumulation sites were rated as RCRA acceptable. Since the majority of AF installations utilize 55 gallon drums (69 out of 72) for hazardous waste collection and storage, increased care must be exercised to ensure that these containers are properly housed. The continued use of marginal and substandard storage/accumulation sites by AF personnel increases the potential for waste spillage and subsequent soil and/or groundwater contamination incidents. This situation can only lead to more RCRA violations and fines directed at

TABLE UI

Waste Storage Site Profile

Command	RCRA Acceptable Sites	Marginal Sites	Substandard Sites
AFLC	3	3	1
AFSC	3	2	2
MAC	2	4	5
SAC	7	8	8
IAC	3	2	8
ATC	1	2	7
Other	0	1	1

AF installations and personnel. The seriousness of this situation is clearly evident from the data depicted in Table UI.

Waste Disposal Practices. Prior to the enactment of the RCRA and CERCLA regulations, many AF installations maintained and operated solid waste landfills. These landfills provided final disposal for many of the wastes generated by the base, some of which are now considered hazardous. Based on the results of this research effort, little on-site disposal of hazardous wastes continues on AF bases. Over ninety percent (66 out of 73) of the respondents indicated that no on-site disposal operations were being conducted. The two major

exceptions being spent EOD material disposal and acid neutralization. Out of seventy-one responding installations, seventy indicated that between 75 and 100 percent of their hazardous wastes were being disposed of off-site. This increased reliance on off-site disposal does however, raise several unique questions.

1. How effective will the existing low bid contracting system be in obtaining suitable waste haulers and disposal sites?

2. How can the AF minimize its liabilities associated with Third Party suits under CERCLA?

Waste Reduction Initiatives. The most economical method of managing hazardous wastes is to reduce the amount of waste generated either through reuse or recycling (4:37; 5:109).

TABLE VII

Profile of Waste Reduction Initiatives

Compound	Frequency	Percentage Of Bases Recycling
Oils & Lubricants	55	76.4
Jet Fuels	54	75.0
Other Fuels (Gas, Diesel)	33	45.8
Solvents	29	40.0

The Air Force through AFM 19-14, Management of Recoverable and Waste Liquid Petroleum Products, and T.O. 42B-1-23, Management of Reclaimed, Recoverable, and Waste Petroleum Products, has sought to effectively manage the recovery and reuse of its petroleum products to obtain the maximum benefit for the AF. The data tend to support the conclusion that AF bases are actively pursuing and implementing waste reduction programs. However, a recent Inspector General (IG) survey of seventy-two military facilities concluded that;

Programs to minimize hazardous materials/hazardous wastes are fragmented and ineffective (30).

Since this research effort only sought to identify current waste management practices, no conclusions about the effectiveness of existing practices is offered.

EPC Support

The base Environmental Protection Committee (EPC) provides a multidisciplinary forum for the discussion and resolution of base environmental issues. The committee is chaired by the Installation Commander, and is responsible for the development and implementation of base environmental policies. To be an effective management tool, the EPC must be both an active and a visible organizational body.

Based on the information obtained from the survey questionnaire, hazardous waste management issues are regularly discussed at EPC meetings. Fifty-two out of

seventy-three respondents indicated that hazardous waste issues were always discussed, while seventeen more indicated they were usually discussed.

To determine how effectively the EPC was supporting base hazardous waste initiatives, a two sample Z-test was used to compare the mean hazardous waste management program rating to the mean EPC support rating. Since the size of both populations exceeded thirty, the Central Limit Theorem was invoked and the sample means were approximated by a normal distribution (B:283-285). Survey responses were assigned a numerical ranking as follows;

Rating	Ranking
1. Excellent	3
2. Good	2
3. Satisfactory	1
4. Poor	0

A rejection limit of 0.05 was used to test the hypothesis, that the mean HWMP scores exceed the mean EPC support scores. Hazardous waste management program ratings ranged from a low of zero, to a high of three. The mean rating was 1.603, with a standard deviation of 0.9089. EPC support ratings also ranged from a low of zero, to a high of three. The mean EPC rating was 1.219, with a standard deviation of 1.083. Based on a population size of seventy-three, the Z-test statistic was computed to be 2.319. Since this value is greater than the desired rejection level value of 1.645, the alternate hypothesis is accepted, and a statistically significant

difference does exist between the HWMP and EPC support mean scores.

TABLE VIII

Comparison of Mean HWMP and EPC Support Ratings

Command	Mean HWMP Rating	Mean EPC Rating
AFLC	1.600	0.800
AFSC	1.714	1.429
MAC	1.727	1.545
SAC	1.478	1.217
IAC	1.667	1.267
ATC	1.800	1.100
Other	0.500	0.000

This finding is extremely significant as it indicates that base Environmental Coordinators consider the support provided by the EPC as inadequate. Although hazardous waste issues are routinely briefed at EPC meetings, these results strongly suggest that the EPC is not actively involved in the base hazardous waste management program, and probably is only providing a cursory review of these issues. If this is in fact true, the EPC is not providing the leadership necessary to effectively manage the base's environmental programs.

TABLE IX

Command Profile of HWMP and EPC Support Ratings

Command	Total Responses	EPC Rating > Sat	HWMP Rating > Sat	EPC Rating < Sat	HWMP Rating < Sat
AFLC	6	1	3	3	0
AFSC	7	3	4	1	1
MAC	11	5	6	3	1
SAC	23	9	12	7	4
IAC	15	5	7	4	0
ATC	10	3	6	3	1
Other	2	0	0	2	1

Table IX shows that Environmental Coordinators rated EPC support as unsatisfactory three times more frequently than they did hazardous waste management program activities. This further suggests that many base Environmental Coordinators do not consider the Environmental Protection Committee as an effective management body.

Approximately thirty-five percent (25 out of 73) respondents indicated that their base had a subcommittee to the Environmental Protection Committee for hazardous wastes. Intuitively you might think that the existence of a hazardous waste subcommittee would tend to increase the Environmental Coordinators ratings for both the hazardous waste management program and the EPC's support of that program. To test these

hypotheses, a two sample t-test was performed on the data (8:287-290). Based on the results from these analyses, no significant differences were noted between the mean scores for the HWMP or the EPC support ratings. These results further support the contention that the Environmental Protection Committee is not an active participant or supporter of base level hazardous waste management actions.

TABLE X

AF Notices of Violation (NOV's)

Cause	Frequency
Inadequate Records	13
Improper Drum Management	9
Inadequate Storage Areas	9
Inadequate Accumulation Sites	8
Inadequate Plans	8
Improper Waste Disposal	5
Administrative Violations	5
Improper Manifests	4

Problem Areas

Notices of Violation (NOV's). Of the seventy-four bases responding to the survey questionnaire, twenty-two indicated that they had received a RCRA Notice of Violation within the past year. Of these twenty-two, six bases indicated that

they had received two or more NOU's. A listing of individual NOU causes is available as Appendix E to this report. The data presented in Table X illustrate the major types of discrepancies noted on AF violation notices. It is apparent from this data that the majority of AF violations can be grouped into two distinct categories: 1) Paperwork related violations, and 2) Waste storage site violations.

The discrepancies observed under the paperwork category typically included some or all of the following items;

1. Inadequate training records.
2. Inadequate plans (Closure, Waste Analysis).
3. Improper waste manifesting.
4. Inadequate labeling and signs.

Of these, the lack of adequate training records and the inadequacy of existing waste labels/warning signs were the most frequently cited violations. Based on the large number of paperwork related violations observed, it appears that the base level Environmental Planning Function is not sufficiently manned to effectively manage their sites hazardous waste program. Fewer than thirty-six percent of the AF installations surveyed, indicated they had a dedicated hazardous waste management staff. Of these twenty-six bases, fifteen were one man shops. To determine if the existence of a dedicated hazardous waste management staff does in fact increase a base's HWMP and EPC support ratings, a two sample t-test was performed on the survey data (8:287-290). A two

sample t-test was chosen since the number of sites with a dedicated hazardous waste management staff was small (i.e. less than thirty). A rejection level of 0.05 was again chosen to test the hypothesis that there is a significant difference between the mean EPC support and HWMP ratings at AF installations with dedicated hazardous waste management staffs. From the data presented in Table XI, the mean EPC support and HWMP ratings along with applicable standard deviations and population sizes were determined.

TABLE XI

Comparison of HWMP and EPC Support Ratings for Installations with/without Dedicated HWMP Staff

Command	With HWMP Staff			Without HWMP Staff		
	#	Mean HWMP Rating	Mean EPC Rating	#	Mean HWMP Rating	Mean EPC Rating
AFLC	4	1.750	0.750	1	1.000	1.000
AFSC	1	1.000	1.000	6	1.833	1.500
MAC	6	1.833	2.000	5	1.600	1.000
SAC	3	3.000	1.667	20	1.250	1.150
TAC	8	1.875	1.250	7	1.429	1.286
ATC	4	2.000	1.250	6	1.667	1.000
Other	0	-	-	2	0.500	0.000

TABLE XII

HWMP vs EPC Support Rating Statistical Parameters

Parameter	With HWMP Staff	W/O HWMP Staff	t-statistic
Mean HWMP Rating	2.000	1.404	2.684
Standard Deviation	0.938	0.851	
Mean EPC Rating	1.385	1.127	0.936
Standard Deviation	1.169	1.035	
Sample Size	26	47	

Table XII summarizes these statistical parameters and presents the computed values for the t-test statistic. The data conclusively shows that there is a statistically significant difference between the mean HWMP ratings for AF installations with hazardous waste management staffs compared to those without such a function. Specifically, those bases with a dedicated hazardous waste management staff obtained higher effectiveness ratings than those bases without one. This finding vividly illustrates the need for increased manning and job specialization within the base level Environmental Planning Function. Since the majority of AF facilities with dedicated hazardous waste staffs only employ one individual, it seems likely that this should be an adequate manning level at most AF installations. Based on the data obtained in this research effort, the establishment of a dedicated hazardous waste management staff at the base

level should dramatically improve the effectiveness of AF hazardous waste management programs. Although the data clearly indicated a significant difference between mean HWMP ratings, no such trend was observed for the EPC support ratings. The lack of any direct correlation between the HWMP ratings and the EPC support ratings seems to indicate that the EPC's support and involvement in base hazardous waste management initiatives is poor. This lack of EPC support was evident throughout this research effort. Regardless of how the data were categorized or segregated, EPC support ratings were consistently lower than those observed for the HWMP. Based on these findings, one can only conclude that the EPC is not assuming a leadership role in base hazardous waste management activities, and may not be for other environmental programs.

The second major category of violations observed in this research effort, involved problems associated with AF hazardous waste storage site practices. Of these violations, the following types of problems were most frequently identified.

1. Accumulation storage > 90 days.
2. Improper drum labeling.
3. Open storage drums.
4. Inadequate storage facilities.
5. Lack of site warning signs.

The majority of these types of problems are all linked to the lack of an adequate management program at AF waste storage sites. Base personnel generating hazardous wastes typically do not consider waste accumulation points as part of their assigned work area, and look to Civil Engineering or DRMO for the management of these areas. Since neither Civil Engineering nor DRMO are staffed to perform this function, AF hazardous waste storage sites often go unmanaged. This general basewide lack of environmental awareness is a serious problem. Unfortunately, it is often the norm and not the exception on AF installations. Only through increased training and publicity can these existing attitudes and perceptions be changed. An active EPC could provide the ideal medium for changing these misconceptions.

Command Areas of Concern. A review of the command EPC minutes for the period of 31May85 through 31May86 clearly showed that hazardous waste issues were a primary concern at the headquarters level. Although the focus of the command EPC is typically on the "big picture", several interesting AF wide issues were identified.

1. The need for additional environmental manpower at the base level.
2. The need for improved hazardous waste reduction initiatives.
3. Implementation problems associated with the 1984 RCRA amendments.

4. The lack of an acceptable number of long term hazardous waste storage facilities.

5. The need to stress the importance of in-house hazardous waste management programs.

6. The reduction of the number of NOV's received.

A complete listing of the command identified problem areas is attached as Appendix D.

Summary

This chapter reported the findings and analysis of the research data. The answers to research questions one, two, and three were provided along with an analysis of the possible reasons and consequences of these findings. The next chapter, Conclusions and Recommendations, will use the research findings to develop a "profile" of existing AF hazardous waste management practices, and will provide recommendations for possible future research efforts.

V. Conclusions and Recommendations

The overall objective of this research effort was to provide decision-makers with a baseline profile of current AF hazardous waste management practices. This goal was achieved, and important insights were gained into the strengths and weaknesses of the AF's waste management program. Conclusions about the research questions outlined in Chapter I are presented in order. The last section of this chapter provides some final recommendations and suggestions for future research.

Conclusions

Research Question One. What are the existing hazardous waste management practices at AF installations?

The majority of AF bases have established a solid foundation for the effective management of their hazardous wastes. The development and implementation of local Hazardous Waste Management Plans, waste reduction/reuse initiatives and the elimination of on-site hazardous waste disposal operations, are all indicative of an environmentally sound management program. Unfortunately, many other AF hazardous waste management practices are far less sound.

Since no standard hazardous waste identification procedure exists, many AF waste management personnel are using inaccurate or incomplete waste analysis information to classify their hazardous wastes. This typically results in

the misclassification or "worst case" classification of the waste stream, thereby increasing both disposal costs and AF liabilities.

By far the weakest links in the AF's hazardous waste management program are its hazardous waste storage sites. Although DRMO provides long term storage at most AF bases, these facilities generally do not meet the minimum storage standards outlined by the RCRA regulations. The lack of adequate waste storage facilities is forcing many AF installations to house their wastes at marginal or substandard locations pending disposal. The continued storage of hazardous wastes at these sites greatly increases the likelihood of future soil or groundwater contamination incidents. AF accumulation points are used to collect and store hazardous wastes for short periods of time (< 90 days). Since the hazardous materials are not housed for extended periods, less stringent rules apply to these areas. Unfortunately, typical AF accumulation sites are often poorly managed and seldom, if ever, maintained. This lack of management control strongly increases the potential for hazardous waste spillage. The existence of these weaknesses poses a significant threat to the AF's hazardous waste management program and require immediate attention and correction.

Research Question Two. What role does the Environmental Protection Committee (EPC) play in supporting the base's hazardous waste management program?

The majority of AF installations indicated that hazardous waste issues were routinely discussed at base EPC meetings. However, based on an analysis of the survey data, it is very evident that the EPC is not actively supporting nor involved in the base's hazardous waste management program. Since the primary function of the EPC is to establish and implement base environmental policy, their lack of support seriously undermines the effectiveness and acceptability of any proposed hazardous waste management initiative. Unless the EPC actively supports the base's waste management program, it is doomed to failure before it even gets started. A renewed emphasis on educating and training of EPC members on their roles and responsibilities needs immediate attention.

Research Question Three. What are the major problem areas facing Air Force Environmental personnel?

The most pressing problem currently facing AF Environmental personnel is the lack of technically qualified individuals at the base level. Only twenty-six out of seventy-three bases have a dedicated hazardous waste management staff. As it exists today, the base Environmental Planning Function can not effectively manage the large number of environmental rules and regulations it is tasked to comply with, of which RCRA is only one. This research effort clearly shows that hazardous waste management activities alone require at least one additional individual within the Environmental Planning shop.

Although inadequate manning continues to plague most AF Environmental shops, inadequate waste storage facilities, the lack of EPC support, and a general lack of environmental awareness basewide seriously threaten even the most simple waste management proposal.

Recommendations

The findings of this research effort clearly show the need for improvement in the AF's hazardous waste management program. Specifically four major problem areas need to be addressed;

1. The existing base Environmental Planning Function is not adequately staffed to effectively manage the AF's hazardous waste management program. If the program is to be successful, additional AF manning or contract personnel must be brought on board immediately. Ideally each AF base should be assigned at least one dedicated waste management specialist.

2. A second recommendation that should help improve the effectiveness of the AF's hazardous waste management program involves educating and training base EPC representatives of their duties and responsibilities as outlined in AFR 19-8. One possible method for accomplishing this training would be to increase the number of offerings of the Environmental Protection Committee members course, MGI 004, at Wright-Patterson AFB, Ohio and to strongly encourage all EPC

members to attend this course. If any base environmental program is to succeed, strong EPC support and involvement are essential.

3. AF accumulation points must be better managed and maintained. Accumulation point managers need to be identified and trained on the proper procedures for waste collection, storage, marking and inspection. Detailed record keeping procedures also need to be established to check for compliance.

4. Lastly, a general environmental orientation and awareness briefing should be developed for basewide distribution. This training should stress the importance of environmental issues to the base populace and attempt to foster a sense of local responsibility and commitment. This briefing could be incorporated and given with other mandatory annual briefings such as Comsec, Opsec and Safety.

Future Research

A major problem area identified in this research effort was the apparent lack of EPC involvement in base hazardous waste management activities. Additional research into why the EPC is not providing effective leadership appears warranted. The results of such an investigation could shed some light on what the expectations and perceptions of EPC representatives are.

A second area suitable for additional research concerns the development of a realistic manning standard for the base Environmental Planning Function. Since the existing standard was established prior to the recent barrage of new environmental rules and regulations, its parameters do not accurately reflect existing work requirements or manpower needs.

Appendix A: Survey Instrument

Hazardous Waste Management Survey
USAF Survey Control No. 86-82, expires 1Sep86.

The information obtained from this survey will be used for statistical purposes only. Your anonymity will be assured as individual responses will not be used to identify specific respondents or bases.

The purpose of this survey is to identify current base hazardous waste management practices, procedures and conditions. Please mark your answer directly on the survey. Circle the letter next to the response you think is best.

1. To which Major Command does your base belong?
 - a. AFLC
 - b. AFSC
 - c. MAC
 - d. SAC
 - e. IAC
 - f. Other (Specify)
2. Is your base classified as a "small quantity generator" as defined by RCRA?
 - a. Yes
 - b. No
3. Does your base have a formal written hazardous waste management plan?
 - a. Yes
 - b. No
 - c. Draft plan only
 - d. Being prepared/reviewed

IF YOU ANSWERED NO ABOVE, PLEASE SKIP TO QUESTION 12.

4. Who developed and wrote your base's hazardous waste management plan?
- a. Base Environmental Coordinator
 - b. Base Civil Engineering Representative
 - c. Base Bioenvironmental Engineer
 - d. EPC Subcommittee
 - e. Other (Specify)
5. Who is responsible for updating and maintaining your hazardous waste management plan?
- a. Base Environmental Coordinator
 - b. EPC Subcommittee
 - c. Base Civil Engineering Representative
 - d. Base Bioenvironmental Engineer
 - e. Other (Specify)
6. How frequently is your hazardous waste management plan updated?
- a. Every 6 months
 - b. Annually
 - c. Every 3 years
 - d. As required
 - e. Never
7. Are copies of your hazardous waste management plan available at generating, accumulating, storage, and disposal activity sites?
- a. Yes
 - b. No
8. Has your hazardous waste management plan been briefed to and approved by the base Environmental Protection Committee(EPC)?
- a. Yes
 - b. No

9. Does your base have a full time dedicated staff for managing hazardous wastes?
- a. Yes
 - b. No
10. If #9 yes, how many individuals are assigned to this staff?
- a. 1
 - b. 2
 - c. 3
 - d. 4
 - e. 5 or more
11. How would you rate your base's overall hazardous waste management program?
- a. Excellent
 - b. Good
 - c. Satisfactory
 - d. Poor
 - e. We don't have a program
12. How frequently are hazardous waste issues discussed at your base EPC meetings?
- a. Always
 - b. Usually (3 or more times per year)
 - c. Sometimes (2 or less times per year)
 - d. Never
13. Does your base have a designated subcommittee of the EPC for hazardous wastes?
- a. Yes
 - b. No
14. If #13 yes, which of the following organizations or individuals are members of your hazardous waste subcommittee?
- a. Base Bioenvironmental Engineer
 - b. Base Environmental Coordinator
 - c. Supply
 - d. Transportation
 - e. DRMO
 - f. Other (Specify)

15. How would you rate the overall activity and effectiveness of the Environmental Protection Committee (EPC) in supporting your hazardous waste management program?

- a. Excellent
- b. Good
- c. Satisfactory
- d. Poor
- e. Doesn't support program

FOR THE REMAINING QUESTIONS PLEASE MARK ALL ANSWERS WHICH APPLY TO YOUR INSTALLATION

16. Does your base have a centralized hazardous waste storage facility?

- a. Yes
- b. No
- c. Facility under construction
- d. Programmed FY87
- e. Programmed FY88
- f. Programmed FY89
- g. Programmed FY90 or beyond

17. Is your base serviced by a DRMO and do they store hazardous wastes?

- a. DRMO accepts and stores wastes
- b. DRMO accepts but does not store wastes
- c. DRMO does not accept or store wastes
- d. Not serviced by DRMO

18. How are hazardous wastes identified at your base?

- a. Routine Chemical Analysis
- b. Material Safety Data Sheets
- c. Container Labels & Warnings
- d. Generator/User Input
- e. Base Environmental Coordinator Input
- f. Base Bioenvironmental Engineer Input
- g. Other (Specify)

19. Which of the following hazardous waste streams are segregated for recycling/reuse at your base?
- a. Jet Fuels
 - b. Fuels
 - c. Solvents
 - d. Oils/Lubricants
 - e. Other (Specify)
20. How are hazardous wastes stored at your site?
- a. 55gal drums
 - b. Underground tanks
 - c. Aboveground tanks
 - d. Lagoons
 - e. Waste piles
 - f. Other (Specify)
21. Which of the following statements best describes the "typical" storage/accumulation area at your installation?
- a. Drums and/or tanks on grass, gravel, or asphalt - no concrete dike
 - b. Drums and/or tanks stored in open diked area
 - c. Drums and/or tanks stored in enclosed diked area
 - d. Other (Specify)
22. Does your base dispose of hazardous wastes on-site?
- a. Yes
 - b. No
23. If #22 yes, which of the following disposal techniques do you employ?
- a. Neutralization
 - b. Recycling/Reuse
 - c. Incineration
 - d. Landfilling
 - e. Other (Specify)
24. Approximately what percentage of your base's hazardous waste products are disposed of off-site?
- a. Less than 25%
 - b. 25 to 49%
 - c. 50 to 74%
 - d. 75 to 100%
 - e. No wastes disposed of off-site

25. How many Notices of Violation (NOV's) or RCRA violations have you received in the past 12 months for hazardous waste management deficiencies?
- a. None
 - b. 1
 - c. 2
 - d. 3
 - e. 4
 - f. 5 or more
26. Please briefly describe the nature of each NOV or RCRA violation below.

THANK YOU VERY MUCH FOR TAKING THE TIME TO COMPLETE THIS SURVEY

Please return your completed survey in the envelope provided. If the return envelope is missing, please send your survey to:

Mr. George Drawett
AFII/LSG
School of Systems and Logistics
Wright-Patterson AFB OH 45433

If you would like a copy of the results from this survey please indicate your mailing address below.

Appendix B: Survey Results

Survey Number	Questions 1-14													
1	A	B	A	A	A	B	A	B	A	C	C	A	B	-
2	A	B	A	E	E	B	A	B	A	B	B	A	B	-
3	A	B	A	-	-	-	-	-	-	-	-	-	-	-
4	A	B	A	A,E	A	B	A	B	B	-	C	B	A	A,B,E
5	A	B	A	E	A	D	A	B	A	C	B	A	B	-
6	A	B	A	A	A	D	A	A	A	E	B	D	B	-
7	B	A	A	A,B	A	B	B	A	B	-	C	A	B	-
8	B	B	A	A	A	B	A	A	B	-	D	C	B	-
9	B	A	A	A	A	D	A	A	B	-	A	A	B	-
10	B	B	A	A	A	B	A	A	B	-	A	B	A	A,B,E,F
11	B	B	A	A	A	B	A	A	B	-	B	A	A	A,B,E
12	B	A	A	A	B	B	A	A	A	A	C	A	A	A-F
13	B	A	A	D	C	D	A	A	B	-	B	B	B	-
14	C	B	A	A	A	D	B	A	B	-	D	A	A	A,B,D,F
15	C	A	A	A	A	D	A	A	A	A	C	B	B	-
16	C	A	A	A	A	B	A	A	B	-	A	B	B	-
17	C	B	A	A	A	A	A	A	A	C	C	A	A	A,B,E,F
18	C	B	A	A	A	D	A	A	B	-	C	B	A	B
19	C	B	A	A	A	D	A	A	B	-	B	B	B	-
20	C	B	A	A	A	B	A	A	A	A	B	A	A	A,B,C,F
21	C	B	A	A	A	B	A	A	A	A	C	A	A	A,B,C,E

Survey
Number

Questions 1-14

22	C	B	A	E	A	D	A	A	A	D	A	A	B	-
23	C	A	A	A,E	B	B	A	A	A	E	A	A	A	A,B,C,E
24	C	B	A	D	A	B	A	A	B	-	B	A	A	A-C,E,F
25	D	B	A	A	A	B	A	A	B	-	C	A	A	A,B,E,F
26	D	B	A	A	A	B	A	A	B	-	C	B	A	A-F
27	D	B	A	A	A	B	A	A	B	-	B	A	A	A,B,E,F
28	D	B	A	E	E	B	A	A	A	E	A	A	A	A,C,D,E
29	D	B	C	A	A	B	A	A	B	-	B	A	B	-
30	D	A	A	A	A	B	B	A	A	A	A	A	B	A-E
31	D	B	A	A	A	C	A	-	B	-	C	B	B	-
32	D	B	A	A	B	B	A	A	B	-	D	C	A	A,B,D-F
33	D	A	A	B	C	D	B	A	B	-	C	A	B	-
34	D	A	D	A	A	B	B	B	B	-	C	A	B	-
35	D	B	A	A	A	D	A	A	B	-	B	A	B	-
36	D	A	A	B	A	B	A	A	B	-	C	A	B	-
37	D	B	A	A	A	D	A	A	B	-	B	A	B	-
38	D	B	A	A	A	D	A	A	B	-	B	A	B	-
39	D	B	A	A	A	D	A	A	B	-	D	C	B	-
40	D	A	C	A	A	E	B	B	B	-	C	A	B	-
41	D	-	A	A,B	A,C	C	A	B	B	-	D	B	B	-
42	D	A	A	A	A	B	A	A	B	-	B	A	A	A,B,E,F
43	D	B	A	A	A	A	A	A	B	-	B	A	B	-
44	D	A	A	A	A	B	A	A	A	B	A	C	A	A-F
45	D	B	A	-	A	C	B	A	B	-	B	A	A	A-E

Survey
Number

Questions 1-14

46	D	B	A	A	A	D	A	B	B	-	D	A	A	A-D
47	D	B	A	A,D	A	B	A	A	B	-	B	A	B	-
48	E	B	A	A	A	B	A	A	A	A	C	A	A	A,B,F
49	E	B	A	A,B	A,C	B	A	A	A	A	B	A	B	-
50	E	B	A	A	A	B	A	A	B	-	C	A	B	-
51	E	B	A	A	A	C	A	A	B	-	C	A	A	A,B,E,F
52	E	A	A	A	A	B	A	A	A	B	A	A	B	-
53	E	B	A	A	A	B	A	A	A	A	B	A	A	A,B,C,E
54	E	B	D	E	A	B	B	B	A	A	C	A	B	-
55	E	B	A	A	A	B	A	A	A	A	A	A	B	-
56	E	B	A	A	A	B	A	A	A	A	C	A	B	-
57	E	B	A	E	A	B	A	A	B	-	C	A	B	-
58	E	A	A	A	A	B	A	B	B	-	B	B	B	-
59	E	B	A	E	A	B	A	A	B	-	B	A	B	-
60	E	B	A	A	A	B	A	A	B	-	C	A	B	-
61	E	B	A	A	E	C	A	A	A	C	B	A	B	-
62	E	B	A	A	E	B	A	A	B	-	B	B	B	-
63	F	A	A	A	A	D	A	A	B	-	C	B	A	A,B,F
64	F	B	A	A	B	B	A	A	B	-	C	B	B	-
65	F	B	A	A	A	D	A	A	B	-	A	A	B	-
66	F	B	A	A	A	D	A	A	A	A	A	A	B	-
67	F	B	D	A	A	B	B	A	A	A	D	B	B	-
68	F	A	A	A	A	B	A	A	A	A	A	B	B	-
69	F	B	A	A	A	B	A	A	B	-	C	A	B	-

Survey
Number

Questions 1-14

70	F	A	A	A	A	B	A	A	B	-	B	A	A	A,B,F
71	F	B	A	A	A	B	A	B	B	-	C	A	B	-
72	F	B	A	A	A	B	A	A	A	A	B	A	B	-
73	F	A	A	A	A	B	A	A	B	-	B	A	B	-
74	F	A	C	B	C	E	B	B	B	-	D	A	B	-

Survey
Number

Questions 15-25

1	D	A	A	A,D	A	A,C	A,C	B	-	D	C
2	A	A	B	A-D	A,B,D	A	A,C	A	C	D	A
3	-	A,G	A	A,D	A-D	A,B,C	B,C	B	-	D	A
4	C	A,C	A	A-D	A,C	A,E	C	A	B	D	B
5	D	A	A	A	A	A,B	B	B	-	D	B
6	D	B	A	A-D	A-D	A-D	C	B	-	C	B
7	B	D	A	A-F	B,C,D	A	C	B	-	D	A
8	D	B	B	A-D	D	A,D	A,D	B	-	D	A
9	A	A	A	C	B,D	A	C	A	C	D	A
10	C	A	D	A,D,E,G	A,B,D	A	B	B	-	D	B
11	C	A	C	A,D,E,F	A,B,D	A	B	B	-	D	A
12	C	A,C	A	A-G	A-E	A-E	A	A	A,B,D	D	C
13	B	B	D	C,D	D	A,F	C	B	-	D	A
14	D	A	B	C,D,E	A,E	A,C	A	A	A	D	B
15	C	B	B	F	A-D	A,B	A	A	B	D	A
16	A	A	A	A-F	B	A	B	B	-	D	A

Survey
Number

Questions 1S-25

17	C	A	B	B, E, F	A, D	A, B	C, D	B	-	D	A
18	D	A	B	D	A, B, D	A, B	B	B	-	D	C
19	D	A	B	A-D, F	A, D	A, C	A-C	B	-	D	A
20	A	A	B	A	A, D	A, C	A	B	-	D	A
21	C	A	A	C	A	A, B	C	B	-	D	B
22	A	A	A	A-D, F	A-C	A, F	C	B	-	D	A
23	A	A, D	A	A-F	A-D	A-C	A	B	-	D	A
24	B	D	B	B, C, F	A, D	A	A	B	-	D	A
25	C	A	A	A, B	A, D	A	D	B	C	D	A
26	C	B	-	B-F	A-D	A, B	A	B	-	D	A
27	B	A	A	B, C, F	A, D	A	A, C	B	-	D	A
28	B	A	A	A-F	E	A-D	B	B	-	D	A
29	A	A, D	A	A-G	A, B, D	A, B	D	B	-	D	A
30	C	A, E	B	D	A, D	A	C	B	-	D	A
31	D	A	B	D	A-D	A	B	B	-	D	A
32	D	D	B	E, F	A, D	A, B	D	B	-	D	A
33	C	B	B	E	D	A	A	B	-	D	A
34	D	A, D	B	C-F	D, E	A	C	B	-	D	A
35	C	A	A	D-G	A, B, E	A	C	B	-	D	B
36	D	A	A	A, C	A, C	A	A	B	-	D	B
37	C	B, E	A	A-F	D	A, C	B	B	-	D	B
38	B	A	A	A-F	A, C, D	A	C	B	-	D	A
39	D	A, D	A	A, D	C, D	A, F	A, C	B	-	D	A
40	D	B, C	A	B, C	A, C, D	A	A, C	B	-	D	B

Survey
Number

Questions 15-25

41	C	A	A	D	A, B	A-C	A	B	-	D	A
42	B	A	A	A-F	A-D	A	B, C	B	-	D	A
43	A	E	A	D, E, F	A-D	A	C	B	-	D	D
44	B	B, E	A	C-F	A-D	A	D	B	-	D	A
45	B	A	A	A-D	D	A	A	B	-	D	B
46	D	A	B	D	A, D	A-E	A	B	-	D	C
47	A	-	A	A-C	A-D	A	A	B	-	D	A
48	D	A	A	A-F	A, C	A, B	C	B	-	D	A
49	B	A	A	A-F	A, B, D	A	A	B	-	D	A
50	C	B, G	A	A-D, F	A-D	A, C	C	B	-	D	B
51	A	-	-	-	-	-	-	-	-	-	B
52	A, D	A	A	A-C, E, F	A, C, D	A	A	B	-	D	A
53	C	A	A	A-F	A-D	A-C	A	B	-	D	A
54	C	B	C	G	A	A	A	B	-	-	A
55	A	E	B	A, B, D-F	A, B, D	A	C	B	-	D	B
56	D	A	A	A-F	A, B, D	A	A	B	-	D	A
57	C	-	-	-	-	-	-	-	-	-	B
58	C	A	A	A-C	A, B, D	A	B	B	-	D	A
59	B	A	B	A-D	E	A, C	A, B	B	-	D	A
60	C	D	A	A-F	A, D	A, B	A, B	B	-	D	A
61	A	A	A	A-F	A-E	A-C	B	A	A	D	A
62	D	A, E	A	A-G	A, C, D	A	A	B	-	D	A
63	D	A	A	A, B, D-F	A, B, D	A, B	A	B	-	D	A
64	C	B	D	A, B, D-F	A, B, D	B	D	B	-	D	A

Survey
Number

Questions 15-25

65	A	B, D	A	A-F	A-E	A	B	B	-	D	A
66	D	A	B	E	A, C, D	A, C	A	B	-	D	F
67	C	A, F	B	C, D, F	B-D	A, F	D	B	-	D	A
68	B	A	A	B-F	A, C, D	A	C	B	-	D	A
69	B	G	B	A-F	A, C, D	A	A	B	-	D	A
70	D	E	A	C-F	A	A	A	B	-	D	B
71	C	A	A	D	E	A	D	B	-	D	A
72	D	B	A	A-E	C, D	A	A	B	-	D	A
73	D	B	B	E	D	A, C	B	B	-	D	A
74	C	A	B	D	C, D	A	A	B	-	D	A

Appendix C: Pretest Survey Results

Survey
Number

Questions 1-14

1	F	A	C	D	B	-	A	A	A	A	C	-	B	-
2	D	A	A	A	A	B	A	A	B	-	C	C	B	-
3	D	B	A,D	E	E	D	-	A	A	E	D	A	A	A-E
4	B	B	A	A	A	B	A	A	B	-	B	A	B	-
5	C	A	B	-	-	-	-	-	-	-	-	C	B	-
6	D	A	B	-	-	-	-	-	-	-	-	A	B	-
7	E	B	A	E	A,D,E	C	A	A	A	B	C	-	-	-
8	E	B	A	E	E	B	A	A	A	A	B	A	B	-
9	E	B	A,D	A,E	A,E	B	A	B	A	B	B	B	B	-
10	F	A	B	-	-	-	-	-	-	-	-	C	B	-
11	D	A	A	A	A	-	B	-	A	A	B	A	A	B,F
12	A	-	A	E	E	D	B	A	A	E	A	B	A	A,B
13	E	B	A	E	A	C	B	B	A	A	B	A	B	-
14	C	B	A	A	A	D	A	A	B	-	D	B	A	A-E
15	D	A	A,D	-	A	B	A	A	B	-	C	A	B	-
16	E	A	A	B	A	D	A	A	A	C	A	A	A	B
17	D	B	A	A	A	C	A	A	B	-	C	B	A	A,B,D,F
18	F	B	A	A	A	D	A	A	A	B	D	A	B	-
19	C	A	A	D	B	D	B	A	B	-	B	B	B	-
20	F	B	A	-	B	D	A	A	A	-	B	A	A	A,B,E
21	B	-	A	E	E	B	B	B	B	-	B	C	B	-

Survey
Number

Questions 1-14

22	A	B	A	A	A	D	B	B	A	A	C	B	B	-
23	F	A	A	A	A	D	A	A	B	-	B	C	A	A,B,E,F
24	F	B	C	A	A	D	A	A	B	-	D	B	B	-
25	E	B	A	-	C	-	A	-	A	B	B	-	-	-
26	F	B	A	A	A	B	A	B	A	B	A	B	B	A,B,E
27	C	A	C	A	A	B	A	B	A	A	D	B	B	-
28	D	B	A	A	A	E	A	A	B	-	D	C	B	-

Survey
Number

Questions 15-25

1	B	E	A	C,D,E	D	A,F	A	B	-	D	A
2	C	A	A	C,E,F	A,D	A	A	B	-	D	A
3	C	A	B	-	-	-	-	B	-	D	-
4	B	A	A	A,C,D,F	A-D	A	A	A	E	D	A
5	C	F	A	C,D,E	A,B,D	A,C	A	B	-	D	B
6	C	A	B	A,C-F	D,E	A,F	C	B	-	D	A
7	-	A	A	A,B,D,F	A,D	A	A	B	A	D	E
8	D	A	A	A,B,D-F	A-D	A,B	A	B	-	D	B
9	D	A	A	C,G	B,D	A	A	B	-	D	A
10	B	B	A	F	D	F	-	B	-	D	A
11	C	A	B	B,C	A,D	A,B	B	B	-	D	A
12	B	A	B	A,B	-	A,B	C	B	-	D	-
13	D	A	A	B,D-F	D	A	A	B	-	D	C
14	D	A	B	B-F	D	A-C	A,B	A	A	D	-

Survey
Number

Questions 15-25

15	C	A	A	D, F	A, C, D	A	A	B	-	D	B
16	A	A	A	C	B	A, B	B	A	A	D	A
17	C	B	A	B, G	A	A, B	A	B	-	D	B
18	D	A	B	A	A-D	A-C	C	B	-	D	F
19	A	B	A	C, F	B-D	A, B	B	B	-	D	B
20	C	A	A	A	B	A	A, C	B	-	D	B
21	C	A	B	A, D	B	A	A, C	B	-	D	A
22	C	A	B	A-E	A, B, D	A	A	A	A	D	A
23	C	A, F	B	A-F	A, C, D	A	A	B	-	D	A
24	C	B	B	C-G	A	A-C	A	B	-	D	A
25	-	-	B	D-F	D	A	C	-	-	-	-
26	C	D	A	C	D	A	C	-	-	D	A
27	E	G	B	A, C, E	D	A	A, B	B	-	D	A
28	D	B	B	E	A-D	A	A	B	-	D	A

Appendix D: Command Identified Problem Areas

AFLC

1. Implementation problems associated with EPA's new Underground Storage Tank (UST) program.
2. Hazardous waste disposal problems resulting from inadequate DRMS storage facilities.
3. The need for additional environmental personnel at AFLC bases.
4. The importance of stressing hazardous waste reduction programs at AFLC bases.
5. NOV's received;
 - a. Inaccurate Part A.
 - b. Leaking pipeline.
 - c. Illegal PCB storage facility.
 - d. Manifest preparation errors.
 - e. Unmanifested hazardous wastes.
 - f. Accumulation point storage > 90 days.

AFSC

1. Unavailability of suitable waste storage facilities. DRMO is currently nearing completion of Patrick's Facility. When finished it will be the first military facility in the Memphis Region which will be in compliance with the RCRA regulations.
2. Third party suits involving Air Force installations are increasing.
3. Need to stress the importance of hazardous waste identification and response actions to base personnel.
 - a. Hazardous Waste subcommittee formed.
 - b. Accumulation point inspection team proposed.

4. Command goals;

- a. Improve existing hazardous waste training programs.
- b. Encourage new waste reduction/minimization initiatives.
- c. Reduce by forty percent the amount of hazardous wastes generated by 1992.
- d. Stress the importance of in-house inspection programs.
- e. Establish a waste identification program which incorporates chemical analysis of all waste streams.

MAC

- 1. Additional emphasis is needed at base level to ensure proper hazardous waste management practices are being followed.
- 2. Present Environmental Program lacks goals and incentives.
- 3. Implementation problems associated with a program to remove underground storage tanks abandoned prior to 1Jan84.
- 4. NOV's received:
 - a. Leaking base landfill has contaminated area groundwaters.
 - b. \$10,000 fine for improper hazardous waste storage site.
 - c. Third party suit (1 of 574).
 - d. Inadequate vapor controls on JP-4 fueling system.

SAC

- 1. Reorganization of headquarters and base level Environmental Planning Function.
- 2. Impacts associated with the 8Nov84 RCRA amendments;
 - a. Land disposal ban.
 - b. Underground Storage Tank program.
 - c. Waste minimization program.

IAC

1. To reduce the number of NOV's by fifty percent.
2. Need to stimulate environmental awareness at the base level.
 - a. Publicize laws.
 - b. Educate commanders.
3. Need for increased environmental training for all base personnel.
4. A Hazardous Waste Task Group has been formed to review compliance and enforcement of RCRA regulations.
5. New areas of concern;
 - a. Underground Storage Tank program.
 - b. IRP site identification and cleanup.

Appendix E: NOV Causes

Violations

- 1a. Lack of training records.
- 1b. Lack of groundwater monitoring wells at hazardous waste landfill.
- 1c. Improper disposal of hazardous wastes in a solid waste landfill.
- 1d. Lack of training documentation (DRMO).
- 1e. Lack of inspection records (DRMO).

- 2a. Drum bungs left off or missing.
- 2b. Cracks in concrete storage dike.
- 2c. Storage of hazardous wastes in excess of 90 days at accumulation sites.
- 2d. Improperly marked/labeled drums.

- 3a. Improper off-base hazardous waste storage sites.

- 4a. Failure to submit annual waste summary report on time.

- 5a. General compliance order, 25 violations identified.

- 6a. Shipping of EOD material without a hazardous waste manifest.

- 7a. Incomplete hazardous waste storage area.
- 7b. Part B RCRA permit not submitted on time.

- 8a. PCB items stored in excess of 1 year.
- 8b. Improper inspection techniques.
- 8c. Inadequate records.

- 9a. Miscellaneous administrative violations.

- 10a. Inadequate groundwater monitoring program.

- 11a. No accumulation start dates on drums.
- 11b. Open drums.
- 11c. Improper or missing hazardous waste labels and signs.

- 12a. Improperly prepared waste manifests.

- 13a. Lack of a waste analysis plan.
- 13b. Lack of signs at waste accumulation points.
- 13c. Lack of inspection logs/records.
- 13d. Open drums.
- 13e. Lack of labels on waste drums.
- 13f. Inadequate facility closure plan.

- 14a. Miscellaneous administrative violations.

- 15a. Lack of training records.
- 15b. Inadequate facility closure plan.

- 16a. Improperly labeled drums.
- 16b. Open drums.
- 16c. Unknown waste stream composition.
- 16d. Lack of training records.
- 16e. Improperly manifested wastes.
- 16f. Illegal hazardous waste disposal at Fire Training, Battery and Pesticide Shops.
- 16g. No internal alarms at hazardous waste storage facility (DRMO).

- 17a. Illegal disposal of hazardous wastes onto the ground and into storm drains.
- 17b. Improper labeling of drums.
- 17c. Improper hazardous waste manifesting.
- 17d. Inadequate waste storage facility.

- 18a. Improper management of hazardous waste products.

- 19a. Inadequate records.

- 20a. Illegal disposal of hazardous wastes at Fire Training Pit.
- 20b. Inadequate/sloppy accumulation sites.
- 20c. Inadequate records.

- 21a. Inadequate training program.
- 21b. Hazardous waste storage in excess of 90 days.

- 22a. No groundwater monitoring program.
- 22b. Part A permit inaccurate.
- 22c. Operating an unlicensed surface impoundment for hazardous wastes.

- 23a. Inadequate training.
- 23b. Improper labels and signs at accumulation points.
- 23c. Inadequate waste storage sites.
- 23d. Improper closure of underground waste storage tank.
- 23e. Lack of adequate plans (Contingency, Closure, etc.).
- 23f. Improper hazardous waste containers.

- 24a. Inadequate records.
- 24b. Inadequate waste storage facility.

Appendix F: Statistical Tests

Z-Test

The z-test is a statistical hypothesis testing procedure used to determine if the difference between population means is significant. To use the z-test procedure the following assumptions must be true;

1. Both populations are normal, randomly sampled, and independent.
2. The values of the populations variances are known.

If the sample size being considered is sufficiently large, i.e. greater than thirty, the mean values of the populations can be approximated by a normal distribution regardless of the original distribution through the application of the Central Limit Theorem. Therefore if both sample sizes exceed thirty, a large sample z-test statistic can be computed and used to evaluate whether or not the null hypothesis should be rejected or not.

T-test

Like the z-test, the t-test is also used to evaluate if the difference between population means is statistically significant. To use the t-test the following assumptions must be true;

1. Both populations are normal, randomly sampled, and independent.

2. The values of the population variances are equal.

The t-test is used whenever one or both of the sample sizes are small, less than thirty. The test statistic generated by this approach has a t-distribution with $m+n-2$ degrees of freedom, where m and n are the individual sample sizes.

Bibliography

1. Anderson, Myron C. Validation of Air Force Hazard Assessment Rating Methodology. MS Thesis. School of Systems and Logistics, Air Force Institute of Technology (AU), Wright-Patterson AFB OH, September 1985 (AD-A161 066).
2. Beck, Melinda and others. "The Toxic-Waste Crisis," Newsweek: 20-24 (7 Mar 83).
3. Bloom, Gordon F. "The Hidden Liability of Hazardous-Waste Cleanup," Technology Review, 89: 58-66 (Feb/Mar 86).
4. Choi, Yearn H. and Lt Col Peter S. Daley. "Hazardous Waste Management Initiatives in DoD," Defense Management Journal, 19: 30-37 (4th Qtr 83).
5. Cook, James. "Risky Business," Forbes, 136: 106-122 (2 Dec 85).
6. Costle, Douglas M. "Taming Chemical Wastes," EPA Journal, 5: 2-3 (Feb 79).
7. Deland, M. R. "EPA Regulates Hazardous Wastes," Environmental Science and Technology, 14: 777 (Jul 80).
8. Devore, Jay L. Probability & Statistics for Engineering and the Sciences. Monterey, California: Brooks/Cole Publishing Company, 1982.
9. Dombrowski, C. "EPA Prepares to Regulate Small Firms," World Wastes, 28: 36-40 (Jun 85).
10. ----- . "Hazwaste Issues at Top of EPA, Congress Agenda," World Wastes, 28: 28 (Jan 85).
11. Dorge, Carol L. "After Voluntary Liability: The EPA's Implementation of Superfund," Boston College Environmental Affairs Law Review, 11: 443-478 (Apr 84).
12. Dowd, R. M. "Reagan's EPA Budget Request," Environmental Science and Technology, 19: 310-312 (Apr 85).

13. Duffy, Celeste P. "State Hazardous Waste Facility Siting: Easing the Process through Local Cooperation and Preemption," Boston College Environmental Affairs Law Review, 11: 755-804 (Oct 84).
14. Early, A. Blakeman. "A Brief and Appalling Look at Hazardous Wastes," Sierra, 65: 50-55 (May/Jun 80).
15. Ember, L. R. "Garbage is a Waste is a Hazard," Environmental Science and Technology, 11: 230-232 (Mar 77).
16. Evans, Roy B. and Glenn E. Schweitzer. "Assessing Hazardous Waste Problems," Environmental Science and Technology, 18: 330A-339A (Nov 84).
17. "Finding a Home for Hazardous Wastes," Futurist, 18: 66-67 (Dec 84).
18. Fischer, Ann. "The Toxic Waste Dump Problem and a Suggested Insurance Program," Boston College Environmental Affairs Law Review, 8: 421-461 (1980).
19. Friedland, S. I. "New Hazardous Waste Management System," Harvard Environmental Law Review, 1: 89-129 (1981).
20. Friedman, M. "Legislative Aspects of Hazardous Waste Management," Environmental Health Perspectives, 48: 19-23 (Feb 83).
21. Gunter, Booth and Mike Williams. "The Cadillac of Dumps," Sierra, 71: 18-22 (Jan/Feb 86).
22. Hileman, Bette. "Hazardous Waste Control," Environmental Science and Technology, 17: 281A-285A (Jul 83).
23. Jackson, Lee Jr. "Does Your Facility Generate Hazardous Waste?," Translog, 12: 15-16 (Oct 81).
24. Josephson, Julian. "Exposure to Chemical Waste Sites," Environmental Science and Technology, 17: 286A-289A (Jul 83).
25. Kibbler, Richard C. "Those Deadly Hazardous Wastes," Air Force Engineering and Services Quarterly, 21: 30-32 (Summer 82).
26. Marbach, William D. and Joseph A. Cincotti. "Pennsylvania Goes After a Waste Hauler," Newsweek: 31 (18 Jul 83).

27. Oppelt, E. Timothy. "Hazardous Waste Destruction," Environmental Science and Technology, 20: 312-318 (Apr 86).
28. Piasecki, Bruce and Gary A. Davis. "A Grand Tour of Europe's Hazardous-Waste Facilities," Technology Review, 87: 20-29 (Jul 84).
29. Piasecki, Bruce and Jerry Gravander. "The Missing Links: Restructuring Hazardous-Waste Controls in America," Technology Review, 88: 42-52 (Oct 85).
30. "Report from Pentagon Criticizes Defense's Handling of Wastes," Dayton Daily News: 12 (23 Jun 86).
31. Rosbe, W. L. "Transportation of Hazardous Wastes," Natural Resource Lawyer, 17: 509-512 (1984).
32. Shanoff, B. S. "Hazwaste Release Charged to Third Party," World Wastes, 28: 119 (Apr 85).
33. -----, "Parole Denied to Hazwaste Dumping Violator," World Wastes, 27: 32 (Dec 84).
34. Speary, W. A. Jr. "Solid and Hazardous Waste Committee," Natural Resource Lawyer, 15: 353-370 (1982).
35. Sullivan, T. F. P. "Environmental Law," Pollution Engineering, 8: 20,24,28 (Dec 76).
36. "Take a Broad Look at Toxic Chemicals," U.S. News and World Report, 98: 83 (31 Dec 84).
37. TerMaath, Maj Steven G. "The Wurtsmith Test: Aeration Strips Contamination from Groundwater," Air Force Engineering and Services Quarterly, 21: 40-43 (Winter 82/83).
38. Thompson, Maj Gen Robert C. "Environmental Planning and the Decision Process," Military Engineer, 68: 11-13 (Jan/Feb 76).
39. Tucker, Samuel P. and George A. Carson. "Deactivation of Hazardous Chemical Wastes," Environmental Science and Technology, 19: 215-220 (Mar 85).
40. "U.S. is not Alone - Pollution is Global," U.S. News and World Report, 97: 39-40 (18 Jul 83).

VITA

Mr. George M. Drewett was born on 7 January 1954 in El Paso, Texas. He graduated from high school in Rudyard, Michigan, in 1972 and attended the University of Michigan from which he received the degree of Bachelor of Science in Chemical Engineering in December 1976. After graduation he was employed as an Environmental Engineer at Wurtsmith AFB, Michigan. In 1979 he received the Strategic Air Command's Civil Engineer of the Year award, and in 1981 was recognized as SAC's Environmental Engineer of the Year. He then entered the School of Systems and Logistics, Air Force Institute of Technology, in June of 1985.

Permanent Address: 605 N. Huron
Harrisville, MI
48740

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE

REPORT DOCUMENTATION PAGE

1a. REPORT SECURITY CLASSIFICATION UNCLASSIFIED			1b. RESTRICTIVE MARKINGS A174346	
2a. SECURITY CLASSIFICATION AUTHORITY			3. DISTRIBUTION/AVAILABILITY OF REPORT Approved for public release; distribution unlimited	
2b. DECLASSIFICATION/DOWNGRADING SCHEDULE				
4. PERFORMING ORGANIZATION REPORT NUMBER(S) AFIT/GEM/DEM/86S-9			5. MONITORING ORGANIZATION REPORT NUMBER(S)	
6a. NAME OF PERFORMING ORGANIZATION School of Systems and Logistics		6b. OFFICE SYMBOL (If applicable) AFIT/LS	7a. NAME OF MONITORING ORGANIZATION	
6c. ADDRESS (City, State and ZIP Code) Air Force Institute of Technology Wright-Patterson AFB OH 45433-6583			7b. ADDRESS (City, State and ZIP Code)	
8a. NAME OF FUNDING/SPONSORING ORGANIZATION		8b. OFFICE SYMBOL (If applicable)	9. PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER	
8c. ADDRESS (City, State and ZIP Code)			10. SOURCE OF FUNDING NOS.	
			PROGRAM ELEMENT NO.	
			PROJECT NO.	
			TASK NO.	
			WORK UNIT NO.	
11. TITLE (Include Security Classification) See Box 19				
12. PERSONAL AUTHOR(S) Mr. George M. Drewett, GS-12				
13a. TYPE OF REPORT MS Thesis		13b. TIME COVERED FROM _____ TO _____		14. DATE OF REPORT (Yr., Mo., Day) 1986 September
15. PAGE COUNT 94				
16. SUPPLEMENTARY NOTATION				
17. COSATI CODES			18. SUBJECT TERMS (Continue on reverse if necessary and identify by block number)	
FIELD	GROUP	SUB. GR.		
13	02		Hazardous Waste, Waste Management, Contaminants,	
15	05		Waste Disposal, Air Force Facilities	
19. ABSTRACT (Continue on reverse if necessary and identify by block number)				
Title: HAZARDOUS WASTE MANAGEMENT A DESCRIPTIVE STUDY				
Thesis Chairman: Panos Kokoropoulos Professor of Environmental Engineering				
<div style="text-align: right;">Approved for public release, LAW AFB 190-17. <i>[Signature]</i> 29 Sept 82 FOR D. VOLKMER Chief for Research and Professional Development Air Force Institute of Technology (AFIT) Wright-Patterson AFB OH 45433</div>				
20. DISTRIBUTION/AVAILABILITY OF ABSTRACT UNCLASSIFIED/UNLIMITED <input checked="" type="checkbox"/> SAME AS RPT. <input type="checkbox"/> DTIC USERS <input type="checkbox"/>			21. ABSTRACT SECURITY CLASSIFICATION UNCLASSIFIED	
22a. NAME OF RESPONSIBLE INDIVIDUAL Panos Kokoropoulos			22b. TELEPHONE NUMBER (Include Area Code) 153-255-4552	
			22c. OFFICE SYMBOL AFIT/DEM	

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE

The increased emphasis and enforcement of RCRA regulations by the US EPA has prompted AF managers to reevaluate base hazardous waste management activities. This research effort provides management with a profile of the current state of affairs of waste management within the Air Force community. This profile provides the necessary baseline data for managers to develop and support future hazardous waste management plans.

A census of all CONUS base Environmental Coordinators was used to identify existing base hazardous waste management practices. The data obtained in this research effort identified three major problem areas: 1) Inadequate environmental manning, 2) Inadequate waste storage facilities, and the 3) Lack of EPC involvement in the base's hazardous waste management program.

Additional research into the reasons for this lack of EPC support is recommended.

100

UNCLASSIFIED